MACHINERY
February, 1910

THE MELVILLE AND MACALPINE REDUCTION GEAR FOR MARINE STEAM TURBINES

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IT has been evident to the general public for some time past that the steam turbine has not been entirely satisfactory in its application to ship propulsion. There have been many direct evidences of this, such as the papers on the subject read before various technical societies in this country and Europe, and authoritative articles of the same character in various scientific journals. There have been even more ominous indications in the vicissitudes of actual installations. It has been very difficult, for instance, to get figures on the coal and steam consumption of the most important of the turbine-driven steamships. The figures would surely have been given out if they made even a satisfactory showing. There have, furthermore, been one or two actual failures, necessitating a return to reciprocating engines, though doubtless these failures were due to designing with insufficient knowledge or experience in this line.

The Nature of the Problem

The difficulty is that the turbine, to be efficient and compact, must have a high velocity of rotation, while the propeller, working in a dense medium and imparting a comparatively slow velocity to the ship which it propels, should work at a far less rotative speed. Up to the present time this discrepancy has been met by modifying the design of both the turbine and the propeller, running one at a slower speed and the other at a higher speed than would be indicated by a design for economy in either alone. As a result the combination has an efficiency which, while high enough to make its use commercially possible, is, nevertheless, very far below what ought to be obtained.

Among the various compromises that have been suggested are, the use of electrical transmission between a turbine-driven dynamo and a motor driving the screw; a hydraulic transmission-set involving a turbine pump and motor; and the use of gearing. The problem has also in a way been attacked from another angle by using a combination of reciprocating and low-pressure turbine engines.

Of the various direct solutions of the problem proposed, but one has ever been tried on a large scale—the use of gearing to reduce the speed of an efficient turbine to that required for an efficient propeller. An experimental apparatus of this kind in a full-size, high-power application has been designed by Rear Admiral Melville and his engineering associate, Mr. John H. Macalpine. This apparatus was built for them, through the good offices of Mr. George Westinghouse, at the Westinghouse Machine Co., of Pittsburg, Pa. Mr. Westinghouse invited MACHINERY to send an editorial representative to examine this reducing gearing, and investigate its design and construction.

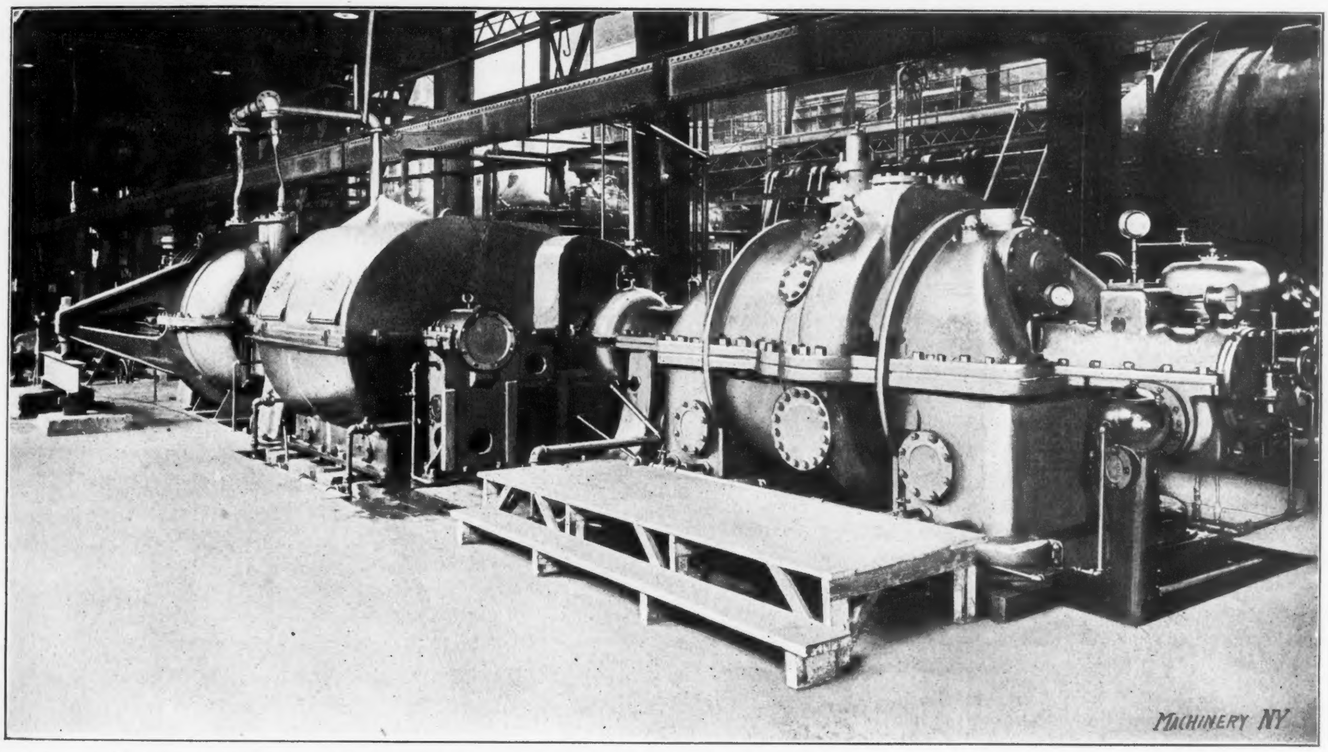

Fig. 1. 6,000-horsepower Steam Turbine, Melville-Macalpine Reducing Gearing, and Hydraulic Dynamometer, set up on Floor of Testing Department

General Description of the Gear

Mr. John H. Macalpine, one of the joint inventors of the gear, and Mr. H. T. Herr, general manager of the Westinghouse Machine Co., very courteously gave their time to explaining to the writer the principles of the construction and operation of the device. It is installed on the testing floor of the plant, as shown in Fig. 1. The steam turbine for driving the gearing in the test is shown at the right. This turbine, running at a normal speed of 1,500 revolutions per minute, is easily capable of giving 6,000 H. P. The gearing itself is mounted in the casing in the center of the line of mechanism. The third member is a water brake or dynamometer of unusually ingenious construction, which will be described later.

The construction of the gears and their supporting mechanism is clearly shown in Figs. 2, 3 and 4. A small pitch was deemed essential if a reasonable absence of noise was to be secured. This necessarily meant broad teeth, in view of the fact that the 6,000 horsepower had to be transmitted at a

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pitch line velocity of nearly 100 feet per second, if the tooth pressure was to be kept within the limits desired. The gearing is of the herringbone type, as shown. The pinions have 35 teeth each, and the gears 176, a hunting tooth being introduced to equalize the wear. The pitch is 1¼ inch and the helix angle is 30 degrees. The thickness of the pinion teeth at the pitch line was made ⅛ inch greater than that of the gear, with the idea of compensating for the more rapid wear to which the pinion would be subjected. Detailed dimensions of the gear teeth are given in Fig. 6. The forgings for the gears were made of an ordinary grade of mild steel, obtained from Messrs. Krupp, and the cutting of the teeth was done by Messrs. Schuchardt and Schütte, of Chemnitz, on the Pfauter gear-hobbing machine. This machine and the hobbing process have been previously described in MACHINERY.*

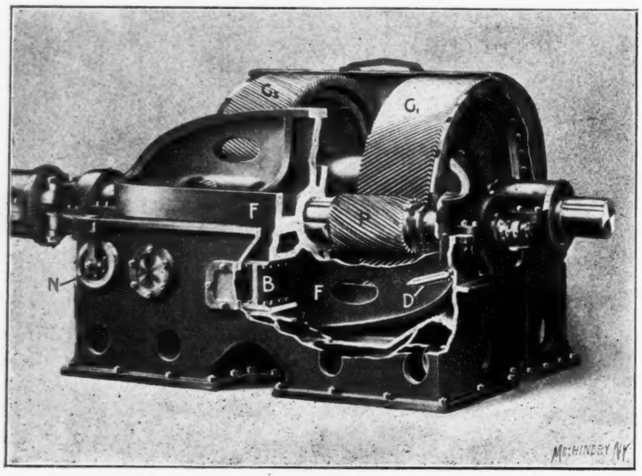

Fig. 2. Sectional View of the Reducing Gearing, showing the Floating Frame

The Floating Frame and Its Action

Two difficult problems had to be solved by the designers in the mounting and use of these gears. One problem is that of the application of a lubricant to teeth running at the high peripheral speed employed. The other problem is the maintenance of a working contact over the full length of face of gears as broad as those here used. In considering the magnitude of this last problem, the great size and power of the gears and the strain to which they are subjected should be remembered; and it should also be stated that, in the opinion of the designers, a separation of even 0.001 inch of the surfaces which should be in contact, would be considered beyond allowable limits. These difficulties have limited the use of herringbone gears in the DeLaval turbine to comparatively small powers; but by the invention of a new method of mounting, they have been here overcome.

In the first place, the sleeve on which the pinion teeth are cut is carried by three liberal bearings in the exceedingly rigid frame F, as shown in Figs. 2 and 4. In Fig. 3 the top of this frame is shown removed. The stiff frame supports the pinion so that its deflection under the load it transmits is negligible. The gear itself is stiff enough without added support, being of a hollow drum construction, somewhat different from that shown in Fig. 2.

It is not merely necessary, however, to give assurance that the pinion shall maintain its rigidity. It must further be so mounted as to accommodate itself to imperfections in its own teeth and those of the gear it runs with, if assurance is to be given that the contact and the distribution of pressure will extend over the whole face of these wide gears. This assurance is given by the mounting of frame F on a flexible support. This support is formed by two sections of an I-beam B, whose elastic web permits frame F to be rocked in a vertical plane parallel with the gear axes, under the influence of forces imposed by the tooth action. These forces will be best understood by reference to Fig. 5.

The pinion sleeve, it should be understood, is free to take its own position longitudinally within a limited range. Neglecting the very slight friction of the well-lubricated teeth, the total forces of the tooth contacts, as indicated by $B\,E$ and $B'\,E'$ in Fig. 5, will be nearly at right angles to the teeth at B and B'—that is to say, they will be at 30 degrees to the vertical; hence the two parallelograms of forces will be similar. Now the horizontal forces at $B\,D$ and $B'\,D'$ are the only axial forces acting on the pinion, owing to the method of driving, which will be explained later. If these forces are not equal, the pinion will at once shift longitudinally, which it is free to do until they are equal. The two parallelograms of forces then become equal to one another in every respect and the vertical force $B\,F$ is equal to the vertical force $B'\,F'$. But besides this longitudinal movement of the pinion, the frame in which it is mounted is free to rotate about the center point O by the flexing of the web of I-beam B (see Fig. 4); hence it follows that the moment of the vertical force $B\,F$ about O must be equal to that of $B'\,F'$ about the same point; as $B\,F$ equals $B'\,F'$, the arms of these levers $O\,B$ and $O\,B'$ must be equal. Thus it is claimed that not only will the total forces on the teeth of P_1 and P_2 be equal, but that the distribution will be made similar by the rocking of the floating frame and the longitudinal self-adjustment of the pinion sleeve, so that the centers of pressure B and B' will be similarly placed.

This equal distribution of the pressure, it will be seen, besides requiring the rocking of the frame, requires absolute freedom in the slight endwise movement of the pinion sleeve. This is secured by an ingenious driving device and universal coupling shown at the farther end of the pinion shaft at the left of Fig. 3, and indicated diagrammatically in Fig. 5. The coupling consists of two flanges C_1 and C_2 mounted on the turbine shaft T and the pinion shaft S. These two couplings are connected together by two transverse links $L_1\,L_2$ and by a center pintle, care being taken not to make this restraint redundant. The shaft T can, therefore, only rotate the shaft S through links L_1 and L_2, and no longitudinal force can be transmitted through these. Even when shaft S is moved longitudinally a considerable distance from its central position, the longitudinal forces are so small as to be negligible. The pinion, therefore, has perfect freedom of axial movement in its bearings. To permit the free rocking movement of the frame, the pinion is driven by shaft S, which passes completely through it to the end distant from the coupling, where it is keyed and bolted. This shaft has clearance in the central hole of the pinion sleeve, and is so flexible that it imposes practically no constraint on the pinion and floating frame.

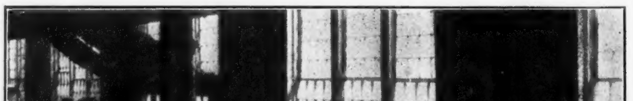

Fig. 3. The Gearing with the Cover and the Top Half of the Floating Frame Removed

Elaborate calculations were made by the designers to find out how much the teeth would come out of contact with each other in varying from normal alignment in the way permitted by the floating frame and its connections. The rigidity of the floating frame, it has been found, is so great, that under full load the end bearings will be lowered relatively to the center by not more than 0.0005 inch.

The effect of the floating frame, as has been described, is

* See article entitled "Gear Cutting Machinery" in MACHINERY, Engineering Edition, May, 1908.

to prevent any opening of contact from errors in alignment in a vertical plane. Without this frame, such errors would be serious. The opening of contact due to a warping of the I-beam supports, and a consequent lack of parallelism in the horizontal plane, has also been investigated; it was found to be negligible for the involute form of tooth, but not so favorable for the cycloidal. The latter also has the disadvantage as compared with the involute that it will not run properly except at the exact center distance, so its use was not considered for this work. The involute form, on careful investigation, showed a number of other advantages which space forbids taking up here.

It was found that the warping of the I-beam supports of the floating frame, while it did not affect seriously the contact of the teeth, was nevertheless unstable. That is to say, there is no tendency to return to a normal position. It was therefore necessary to confine the movement of the frame in this direction. For this purpose struts *D* and *D'* are provided (see Figs. 2 and 4) which leave the frame free to rock, but hold it against horizontal movement. They bear in seats of the frame in one end and on the points of screws at the other, which are adjusted and locked by the mechanism shown at *N* in Fig. 2. This arrangement greatly facilitates the true setting up of the floating frame without interfering to the slightest degree with the freedom of movement in the vertical plane.

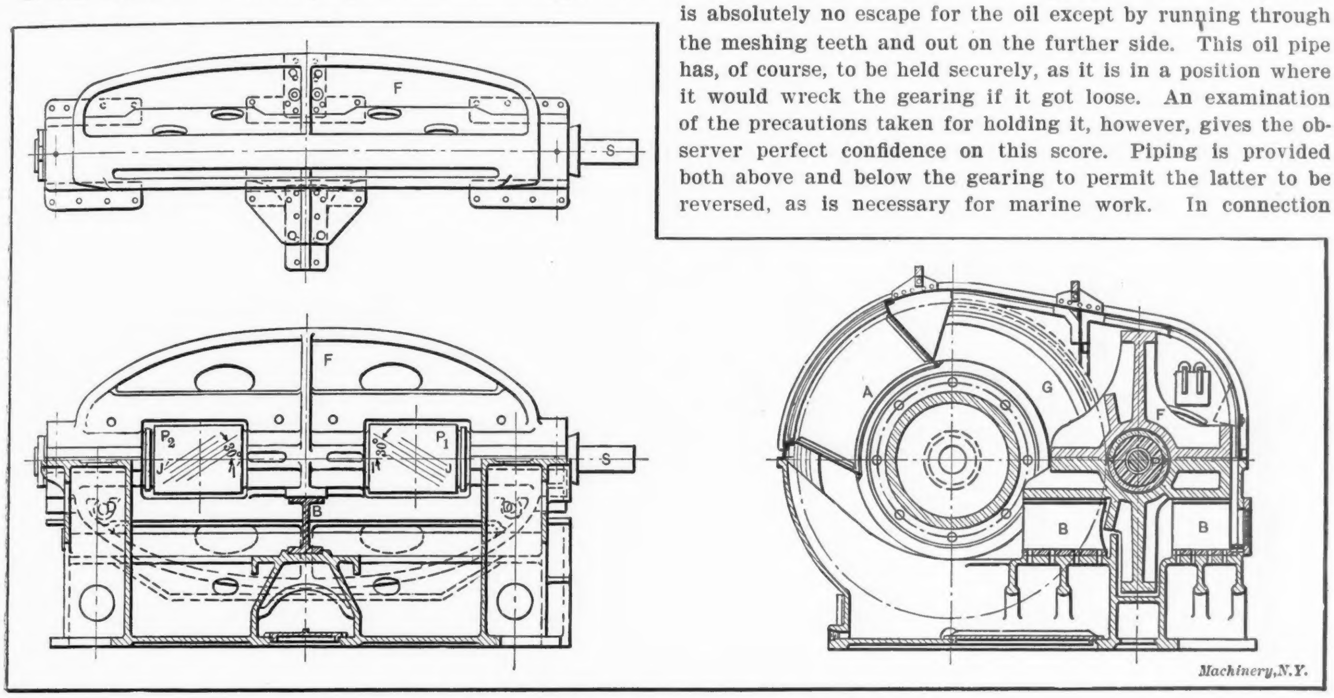

Fig. 4. Details of the Construction of the Gear, showing the Floating Frame, etc.

Oiling the Teeth and Bearings

It was mentioned that the oiling provisions had something to do with the success of the apparatus. Oil is supplied to the bearings under a pressure of about 10 pounds, and runs through them with a constant flow under conditions common to such machinery. Special provisions had to be made, however, to get the oil into the working surfaces of the teeth, where it must be used to reduce the friction or lost work to a minimum, and to give assurance of long life to these working surfaces. Owing to the high peripheral velocity (6,000 feet per minute) oil simply sprayed on the teeth would be immediately thrown off by centrifugal force.

The plan devised for employing the oil effectively consisted in providing a supply pipe with a series of jets directing the lubricant under a considerable head right at the point where the teeth of the pinion are rolling into mesh with the gear teeth. Even when thrown off of the pinion, under these conditions it is thrown back onto the gear, and *vice versa;* there is absolutely no escape for the oil except by running through the meshing teeth and out on the further side. This oil pipe has, of course, to be held securely, as it is in a position where it would wreck the gearing if it got loose. An examination of the precautions taken for holding it, however, gives the observer perfect confidence on this score. Piping is provided both above and below the gearing to permit the latter to be reversed, as is necessary for marine work. In connection with the amount of opening possible for the teeth, it should also be remembered that the presence of oil in the bearings and on the gear teeth tends to lessen this factor below the calculated amount.

While it has not been possible to do more than touch lightly on the immense amount of calculation and investigation undertaken by the designers of this mechanism, the writer has said sufficient, he is sure, to show that the highest degree of technical skill has been brought to bear on the subject, and that the proposition is one of engineering pure and simple, there being no evidence of "cut-and-try" or guesswork methods in the design. It may be said in this connection that the gearing has been carefully calculated to have a large margin of strength over the shafting, which transmits the power to it from the turbine and connects it with the propeller. It is, therefore, confidently believed to be the strongest link in the chain between the turbine and the propeller; and the latter, or the shaft which drives it, will be the first to fail in the event of dangerous racing, the striking of wreckage, or other similar accident.

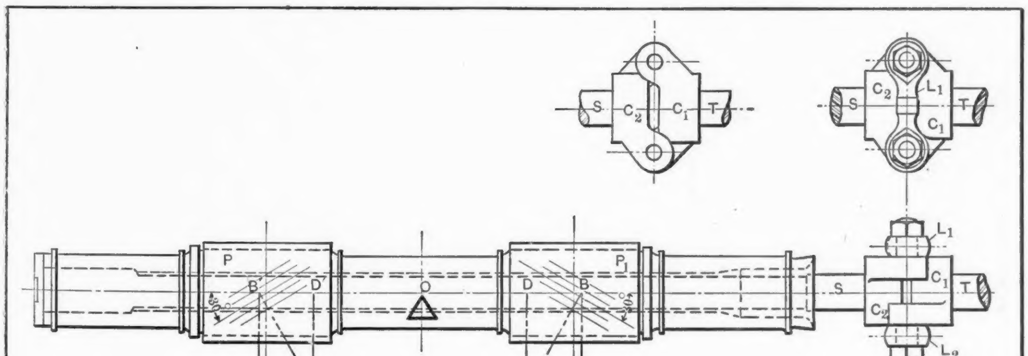

Fig. 5. Action of the Forces on the Gear Teeth in Distributing the Pressure over the Full Width of the Face

Testing the Effect of the Floating Frame

The two points in testing the apparatus were, of course, to determine, first, the character of the bearing obtained; and second, the efficiency of the mechanism. To be sure that the gears have the carrying capacity desired, it must be made certain that the floating frame and other precautions taken

distribute the bearing over the whole length of the teeth. The efficiency was important first from the standpoint of power consumption, and second from the standpoint of durability. The amount of power wasted in a mechanism bears naturally a close relation to its length of life. If it consumes a large amount of power in friction, it may be assumed that it will eat itself away in a short space of time.

Before starting up the machine under power, the teeth of the pinion were red leaded, and it was turned by hand until the large gear had revolved once. At this time the top part

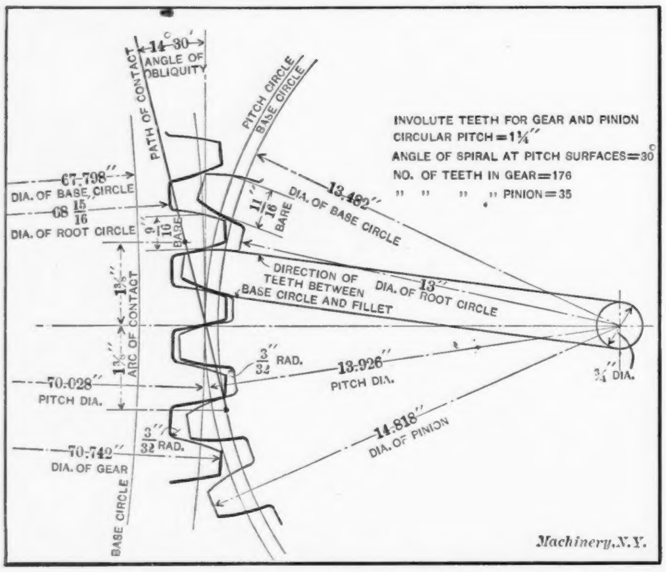

Fig. 6. View of Gear Teeth on Plane at Right Angles to their Axes, showing Dimensions for both Gear and Pinion

of the floating frame was not in place, so that both pinion and gear were fully exposed. It was found that the teeth bore a little hard from one to two inches at both ends of both the right- and left-hand spirals of both the pinion and the gear, and hardly at all in between these points. This was doubtless due to the slight spring in the hob in getting down in to the work and in leaving the cut.

The gear was then run by the turbine at three or four hundred revolutions per minute and with practically no load, without putting the top part of the frame in place. This, of

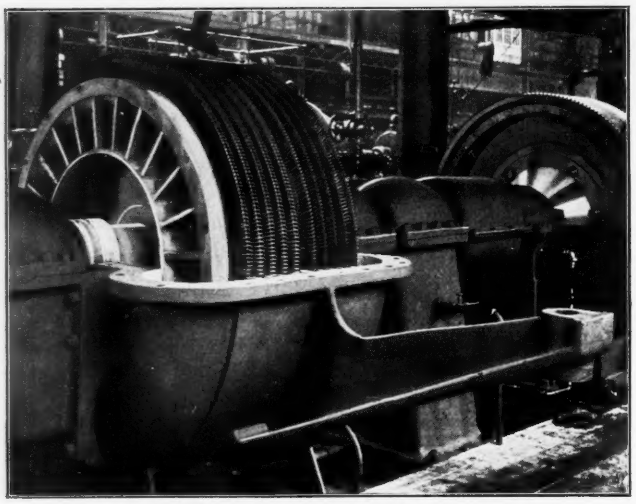

Fig. 7. The 6,000-horsepower Hydraulic Absorption Brake with Upper Half of the Casing Removed

course, brightened the hard bearings at the end of the teeth. These were scraped and then the erection of the gear was completed. After running a second time under light load the bearings came up in spots along the whole length. After a second scraping a load of 6,700 horsepower at 1,500 revolutions per minute was put on. From this time on the markings came up very satisfactorily. It is not probable that these marks are marks of real wear. They are more likely the effect of the application of pressure to the loosened surface left by the cutting and scraping tools.

The accurancy demanded in the cutting, and further refined by the simple scraping operations just described, was of a far higher degree than that met with in any other job of gear cutting within the writer's knowledge. First, the width of face in proportion to the pitch is very great (the total width of face being forty inches); and, second, the stiffness and rigidity of the gears and their mountings are such as to show plainly any inaccuracy of a kind that could not be compensated for by the floating frame.

The Hydraulic Brake

For the efficiency tests, to find a form of brake or dynamometer that would continuously absorb the 6,000 horsepower which it was desired to transmit through this gearing, was no easy matter. When it is considered that the heat generated per hour by the absorption of one horsepower is 2,545 British thermal units, and that for 6,000 horsepower it would be the equivalent of the combustion of 1,200 pounds of coal per hour, the magnitude of the problem is easily comprehended.

An ordinary Prony friction brake would certainly be out of the question. The use of a generator and water rheostat offered other difficulties, particularly in the matter of obtaining the degree of accuracy desired. It was, therefore, determined to build a modification of a hydraulic brake which had been in use in the plant of the Westinghouse Machine Company for many years for the testing of all steam turbines manufactured by it. This brake had to be redesigned for much lower speeds than the original construction, and consequently was of greatly increased size. It is shown set up on the testing floor at the extreme left in Fig. 1, while details of its construction are illustrated in Figs. 7 to 10 inclusive.

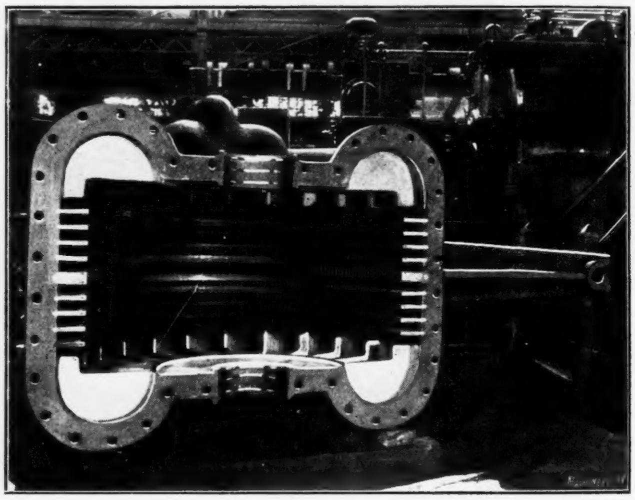

Fig. 8. Interior View of Upper Half of Casing, showing Blades

The dynamometer consists, briefly, of a rotor connected to the source of power and provided with regular turbine blades; a casing containing baffling blades ranged in alternate rows with the turbine blades of the rotor; provision for keeping the casing supplied with a greater or less amount of water which, by the action of the blades, furnishes the resistance; and a mounting for the casing so that it is pivoted about the axis of the rotor, and is restrained from revolving only by a weighing arm extending from the side, which bears on a lever connected to the scale.

Figs. 7 and 8 show the blading very well. This is mounted in the casing and the rotor in the same way as for regular turbine work. Fig. 9 shows the arrangement. The curved blades revolve, while the straight, cross-hatched ones are stationary. Water entering at A moves axially to the right and left, where it is picked up by the curved blades and started to whirling. As it passes through these it is dashed against the stationary blades and constrained to stop its peripheral movement, being forced again axially to the next row of revolving blades, which, in turn, start it to whirling again—and so on. This alternate picking up of the water by the rotor and checking of it by the stationary blades furnishes the resistance to the movement.

The path of the water after it leaves the blades is more plainly seen in Fig. 10. It passes through the curved side passages F in the direction shown, guided by baffle plates.

Here it is again thrown to the interior of the rotor, where it returns to the center opening, marked *A* in Fig. 9. The water is thus passed through the blades over and over again.

The amount of resistance which this dynamometer offers at a given speed is dependent on the amount of water in the casing, so that the load is increased by letting in more water. This is done through passages *C* and *C'*. The immense amount of heat generated may be allowed to pass off in the form of steam through openings *D* and *D'*. Instead of allowing the power to be dissipated entirely in steam, however, it is more practicable to keep a constant flow of water through the brake. The cool water comes in at *C* and *C'*, and goes out heated at *E* and *E'*. By proper manipulation of the valves the amount

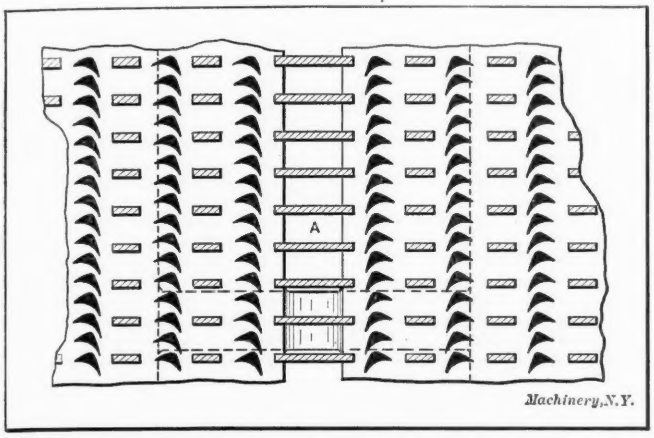

Fig. 9. Arrangement of Rotating and Stationary Blades whose Action on the Contained Water furnishes the Resistance

of water, and the consequent amount of power absorbed, can be very delicately regulated. In Fig. 1 the inlet openings are shown connected to the supply pipe by flexible hose.

Measuring the Power Furnished to the Gearing

The apparatus just described satisfactorily solved the problem of measuring the power delivered by the gearing, which, with the power furnished to the gearing, had to be known in order to ascertain the efficiency. At the beginning of these tests it was found that the ordinary means of measuring the power input, owing to the very high efficiency of the gearing, sometimes gave resulting efficiencies of over 100 per cent. Evidently then, most refined means must be taken for this work.

While the indicator method of calculating power cannot be used on the turbine, it is possible to calibrate any particular machine of this type so that its power is accurately obtained by using the absolute inlet pressure of commercially dry steam as a measure. To do this it was only necessary to keep the speed and the exhaust pressure constant. By substituting for the reduction gearing a dynamometer, connected directly to the turbine shaft, it was then possible to lay out a diagram in which the horsepower output was given for various inlet pressures. This line was practically straight, so that values interpolated between points obtained by actual observation are quite dependable. Tests of the apparatus made with this method of calculating the horsepower input gave efficiencies ranging from 98.5 to 99 per cent with the horsepower varying from 3,771 to 6,057.

The results obtained were so surprisingly good that it was thought advisable to check the tests by using some other method of determining the amount of power lost. For this the simple and very satisfactory method was followed of determining the amount of heat carried away by the lubricating oil coming from the bearings and the teeth of the gears. Practically all the transmission loss in the gear would appear as heat in the oil. In one of the tests checked by this method, when the brake horsepower read 5,088, it was concluded that 64.17 horsepower was accounted for by the heat of the oil, with a resulting efficiency of 98.75 per cent, which agreed with the results obtained in the previous tests. This figure is probably a little too high, as there is an indeterminate small quantity of heat radiated from the gear casing and the oil piping that has not been accounted for. Even if this were 20 per cent of that accounted for, which is not probable, the efficiency indicated would still be 98.5 per cent.

A Forty-hour Test

Besides many shorter trials an extended forty-hour endurance test was given the apparatus. This began at 3:15 P. M., Saturday, October 16, 1909, and continued until 7:15 A. M. on the following Monday morning. This test was witnessed by officials especially delegated for the purpose from the Bureau of Steam Engineering of the United States Navy. During this trial an average load of 6,048 horsepower was carried at a speed for the gear of 300.6 revolutions per minute. There was nothing in the operation of the gear to indicate that this load might not be carried indefinitely.

It will be readily understood that a constant draft of 6,000 to 7,000 horsepower on the boiler plant could not be long maintained without interfering with the regular operations of the company. As a consequence, the duration of the test was necessarily limited to the period between noon on Saturday and the early morning of the following Monday. A continuous test of five or six days, representing the time of an average transatlantic voyage, would doubtless be of more popular interest, but it would be of no more real scientific value. When the parts of the apparatus have once attained a maximum temperature, which remains constant for a reasonable period, and providing that temperature is within the limits generally recognized as conservative, a condition has been established which is capable of being maintained indefinitely. In the present instance the trial continued over thirty-four hours after the temperature conditions had become constant.

Personal Observations

It is, perhaps, as a job of gear cutting that this apparatus will be most interesting to the readers of MACHINERY. For that reason it may not be inappropriate to record some of the personal observations of the writer on the running of the gears. Exceptional opportunities were furnished for observation, as Mr. Herr kindly arranged for the running of the apparatus under a load of 3,000 horsepower which was the

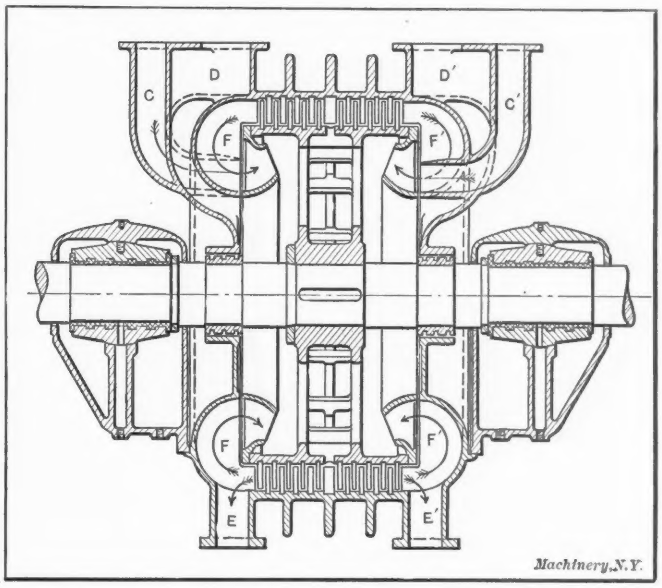

Fig. 10. Section through Hydraulic Brake, showing the Various Water and Steam Passages

full boiler capacity available for testing work without shutting down the machine shop.

Transmitting this 3,000 horsepower and reducing the speed from 1,500 to 300 revolutions per minute, the gearing ran in a way to inspire a high degree of confidence. What noise there was was not objectionable, and some of it was doubtless accounted for by air waves set up by the revolving teeth. There was little or no trace of sounds synchronous with the revolutions of the large gear. The metallic sounds emanating from the casing were of a resonant character, with no indication of grinding or rubbing. This was true even when the sound was transmitted by a pencil resting on the machine

frame and pressed against the lobe of the ear, or by a knife held between the teeth and resting on the frame.

The wide and satisfactory bearing across the whole working surface of the teeth, mentioned in an earlier paragraph, was plainly seen. The action of the floating frame could also be easily observed, owing to the fact that a little inaccuracy had been committed somewhere, perhaps in the mounting of the gears, which caused the pinion and frame to vibrate vertically at each revolution of the large gear. The full bearing just described was maintained by the floating frame under these conditions. The writer was unable to detect with assurance any sound or vibration synchronous with the rate of revolution of the large gear and the rocking of the floating frame, so that the action appeared to be as easy and regular as if conditions had been perfect. In setting up the apparatus the shafts of the two gears were set some 0.020 inch nearer together at one end than at the other, so that this inaccuracy also was taken care of without any harmful effects.

The writer noted scraper marks along the pitch lines of the pinion. On inquiry it was learned that scraping was done to relieve the bearing at the pitch line, where there is no rubbing and consequently little wear. Doing this, it was thought, would tend to make the gears wear more evenly over the whole area. The further away from the pitch line we get in an involute gear tooth the more rapid is the wear. Diagrams showing this have previously been published in MACHINERY.* It has been proposed that this scraping be done occasionally on the pinions while they are in service.

It appears that there is but one probable source of inaccuracy which the floating frame will not take care of. This is inaccuracy in the helix angle. The included angle between the teeth of the gears must be the same as the included angle between the teeth of the pinion. To insure this, so far as the original construction is concerned, it is only necessary to have the gearing ratios in the hobbing machine when cutting the gear and pinion in exactly the same proportion as the ratios between the numbers of teeth in the gear and pinion. It will not do to obtain approximate helix angles. Inaccurate mounting of the large gears might tilt them so that the helix angle would be variable about the circumference. Running with red lead, as described, is a safe test of accuracy in this respect.

At first the writer was inclined to criticise the use of as steep a helix angle as 30 degrees. So far as running smoothly is concerned, the full requirements appear to be met when the gears are given merely enough slant so as to gain a tooth or slightly more in the width of the face of the gear. A very much less angle than 30 degrees would be sufficient under the conditions of lubrication provided for securing the desired sensitiveness to the end movement with varying pressure. There is one other consideration which enters here, however, which inclines one to believe that the larger angle is the better. As explained, the natural tendency of the gears is to wear out of shape and bear only at the pitch line. This would result in a series of point bearings. Now, with a 30-degree angle, such as is shown in Fig. 5, there would be bearing wherever each of the tooth faces, as shown by the diagonal lines, crosses the center line of the engraving. If the angle were smaller there would be fewer points of contact, and if there were a gain of only one tooth in the width of face the tendency would be to wear down to a single point bearing at a time on a single tooth. This, however, would be a tendency only, and would never actually occur, but it is proper to avoid that tendency by increasing the pressure angle. The only disadvantage of a large pressure angle lies in the fact that it makes it more difficult to get a good job of gear hobbing; but as a good job was obtained with the 30-degree angle there was no chance for criticism here.

In the operation of this device it is evident that the temperature of the oil will play an important part in giving warning of possible trouble, in the same way that it determined the efficiency of the apparatus. So long as the oil runs cool, within certain temperatures determined by experiment and experience, so long may the engineer rest assured that the apparatus is working efficiently and without rapid deterioration. The heating of the oil will give him notice to look for trouble. As for errors from accidents, as already explained, the gear teeth are the strongest link in the chain between the turbine and the propeller, so that trouble will be expected elsewhere first.

In regard to the matter of oil temperature it may be stated that in the forty-hour test previously described, absorbing 6,000 horsepower, the average running conditions gave a temperature rise of about 30 degrees Fahrenheit with a flow of about 591 pounds of oil per minute. These temperatures are so low and the consequent efficiency so high that the designers feel confident that the normal capacity of the gear may safely be set much higher than 6,000 horsepower—perhaps as high as 10,000 horsepower.

It will be noted that a rather low grade of material was used. This allows room for a considerable increase in strength and durability without change of proportions. It is possible also to nearly equalize the life of the pinion and the gear by making the former of a considerably higher grade of material. It would be advisable, however, to permit the pinion to wear out the faster, as it is more easily and cheaply renewed than the gear. In view of the high efficiency and consequent small wear of the teeth it would not seem to be necessary to make the pinion teeth thicker than the gear teeth as they are shown in Fig. 6, so the expense of making two hobs for this work can be saved.

Expected Results in Practice

It may, perhaps, be interesting to note some of the advantages that will follow a successful application of this device to marine propulsion. In the case of the *Mauretania* or the *Lusitania*, for instance, it is probable that the steam consumption is at least 14.5 pounds per shaft horsepower per hour, while turbines of similar capacity running at normal speeds, operating with the reducing gear, should not exceed 11 pounds per shaft horsepower per hour. This means that the boiler capacity (taking into account also the improved efficiency of a low speed propeller) could be reduced from 70,000 shaft horsepower to about 45,000 horsepower, making a reduction of over 35 per cent in the coal consumption. Reckoning on unofficial figures, this would make a saving in coal of $5,300 per voyage, with a corresponding decrease in the cost of wages and maintenance. An increased cargo capacity would also result, not only from the reduction of over 1,600 tons in coal, but also in the great reduction in weight of machinery and the space necessary to accommodate it.

Still further advantages are claimed for war vessels, particularly in the matter of economy at the regular cruising speeds. With the smaller dimensions also of the high-speed turbines thus made possible the engineer will be able to start them cold instead of having to pass through the long and (in war time) dangerous warming-up process that now appears to be necessary. Further improvements contemplated for these turbines will entirely obviate any danger in quick starting. The inquiries sent in and the tentative plans under way for both naval and merchant vessel installations for this reducing gear indicate the interest that is felt in it by naval engineers.

Too much cannot be said for the firmness of Messrs. Melville and Macalpine and the courage of Mr. Westinghouse, in determining to make the trial of this construction on a full size model. Anything less than this would have been unsatisfactory. The questionable point was the ability of the apparatus to transmit high powers at high velocities with high efficiency, and this question could only be settled by actually transmitting high powers at high velocities with high efficiency. As an example of engineering and invention this reducing gearing is admirable; as a piece of gear cutting, it is remarkable. Its practical application will be awaited with great interest, and with great confidence as well, on the part of those who have had an opportunity to investigate it.

* * *

One of the most essential details of the aeroplane flying machine is a light-weight motor, which combines reliability and high power with small weight. It is stated by an English journal that Sir Hiram Maxim has designed an all-steel motor of 87 H. P. which weighs only 210 pounds.

* See page 364 of the January, 1909, number of MACHINERY, Engineering Edition.

HEATING AND VENTILATING OFFICES IN SHOPS AND FACTORIES*

CHARLES L. HUBBARD†

The writer's articles in past issues of MACHINERY on shop heating and ventilation have been confined to the machine and erecting rooms, without any special mention of the conditions to be met with in the proper ventilation of the offices and drafting-rooms. As a matter of fact, the requirements are more exacting here than in the shop proper where the cubic space is usually large compared with the number of occupants, and where, under average conditions, the workmen are more actively engaged than those employed in office work. If clear and alert minds are required anywhere about a manufacturing establishment, it is in the offices and drafting-rooms, and such a condition can be brought about only by providing the rooms with an abundance of pure, fresh air at the proper temperature and without drafts.

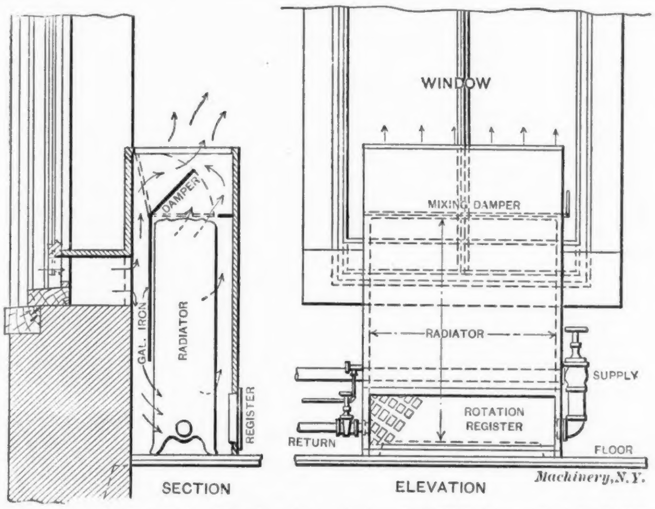

Fig. 1. Arrangement for Heating Air entering from Window, when Radiator is placed directly in front of Window

Rooms of this kind are usually heated by direct radiation, or, if the shops are equipped with a hot-blast system, the air pipes are extended to the offices. In case of direct radiation, there is no means of providing ventilation except through open windows; the drafts produced in this way are a common cause of colds and a general lowering of the efficiency of the office force. Again, the requirements of the shop and the office are not the same, and a hot-blast system which gives satisfactory results in the former may be far from suitable for office ventilation. When the air is rotated within the building it is hardly suitable for the offices on account of odors which it may contain and also because its purity is hardly up to the standard required for this purpose. Again, if the entire air supply for the hot-blast apparatus is taken from out-of-doors, and is therefore of the required purity, the temperature requirements may not be the same for the office as for the shop, and the chances are that the former will become overheated unless the registers or dampers are partly closed which, of course, results in a corresponding reduction in the air supply.

Simple Means for Heating and Ventilating Without Using a Fan

It is the object of this article to point out several different ways, more or less efficient according to their cost, by means of which the ventilation of the offices may be improved. Let us first take the case of an office heated by direct radiators and where the finish of the room is such that the matter of appearance is not of great importance. The arrangements shown in Figs. 1, 2, 3, and 4 can be made without great expense by the shop carpenter, with a little assistance from a galvanized iron worker. The idea in each of these cases is to bring fresh air in through the window by raising the lower sash slightly, and to pass the air over and between the sections of the radiator before delivering it into the room. Arrangements of this kind cannot be depended upon to always deliver a fixed quantity of air like a fan, because the amount will vary somewhat with the strength and direction of the wind and also with the outside temperature, but fair results may be obtained in this way at a very reasonable cost.

The objection is sometimes raised that the radiator being proportioned for direct work only, cannot be depended upon to warm outside air for ventilation also. In a considerable number of cases coming to the attention of the writer, no trouble has ever been experienced from this cause. Direct radiators are commonly proportioned for zero weather and therefore, much of the time, are larger than are necessary, and also, as the air passes over them at a higher velocity and lower temperature, their efficiency is much increased. In extreme weather the amount of fresh air can be reduced temporarily, or the window can be closed entirely and the air rotated over the radiator by openings provided for that purpose.

Fig. 1 shows the method of enclosing a radiator which stands directly in front of a window and projects above the sill. The casing is made of ⅞-inch sheathing with galvanized iron damper and inner casings as shown. When the mixing damper is thrown to its extreme upper position, as shown by dotted lines, all of the entering air passes downward back of the radiator, and then upward between the sections, where it becomes heated and is discharged into the room through the open top of the casing. When it is desired to reduce the temperature of the room, the mixing damper can be thrown to the right, thus admitting a mixture of hot and cold air without reducing to any great extent the volume of air supplied. By closing down the damper on top of the radiator, practically all heat will be shut off. A register placed in the front of the casing, near the bottom, serves to take air from the room when it is desired to use the radiator for heating only, as at night time.

Fig. 3 shows a plan, elevation and section of the casing and damper when the radiator stands at the side of a window instead of in front, as in Fig. 1. In this instance the whole casing is made of galvanized iron, although wood may be used if desired. The general principle is the same here as in Fig. 1, the only difference being its adaptation to another position of the radiator. The register for the rotation of air in this case is replaced by a door in the front of the casing, which may be opened at night or when ventilation is not required.

In Fig. 2 the radiator occupies a position across the end of the room at right angles to the window. Here the arrangement of casing and damper is somewhat different from those already described. In this case the air is delivered into the room through a register face or grille at the end of the boxing, instead of at the top, as before. This arrangement is only adapted to pipe radiators or a deep sectional radiator of very open pattern, as the air passes through it lengthwise instead of upward between the sections. The mixing damper here extends across the end of the radiator and deflects the entering air either through the radiator or over it, according to the temperature desired. The radiator is enclosed in a galvanized iron casing open at each end, while the passages for the cold air are of wooden sheathing, as shown. Air is admited for rotation through a door or register in the wooden boxing.

Sometimes, in buildings of mill construction with heavy brick walls, the radiators are set in recesses in front of the windows. A very satisfactory way of encasing them and admitting fresh air is shown in Fig. 4. With this arrangement no extra space is required, as the front of the casing is in line with the inner face of the wall and does not project into the room. A thorough mixture of the warm and cold air currents is obtained by carrying up a shield above the mixing damper, as shown, and delivering the air near the sash.

Using Fans for Impelling the Air for Heating and Ventilation

Having taken up some of the simpler methods of improving the ventilation in offices and drafting-rooms, let us now consider various ways in which the air supply may be made more reliable under all conditions. The only practical way of doing this is by the use of a fan, and to get the most satisfac-

* For additional information on heating and ventilation, see "Sizes of Pipe Mains for Hot Water Heating," and articles there referred to, in the September, 1909, issue of MACHINERY; also Reference Series No. 39, "Fans, Ventilation and Heating."

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tory results it is best to provide a separate apparatus for these rooms, unless special means are used for regulating the temperature of the air supplied when the regular shop system is made use of. There are two ways of ventilating by means of a fan; one is to exhaust the vitiated air and depend upon inward leakage around doors and windows for a fresh supply, and the other is to force in fresh air and allow the foul air to find its way out either by leakage or through specially provided flues or transoms. Both supply and vent fans are made use of in special cases, but this is not usually necessary under ordinary conditions. The method of supplying fresh air under pressure is more satisfactory for general ventilation, as it gives an opportunity of warming it and also permits of better distribution. When the exhaust system is used the fresh air at outside temperature leaks in, and in so doing is very liable to produce uncomfortable drafts near doors and windows.

The device shown in Fig. 5 is the simplest form of fan supply. This, in a sense, is a makeshift, but for single rooms where it is desired to improve the ventilation without very much expense it may be made to give very good results when properly installed and operated. This is adapted to rooms with sufficient direct radiation to warm them comfortably in zero weather. Such rooms, as already stated, will be overheated a greater part of the time, unless part of the radiators are shut off. The upper part of rooms heated in this way contain a considerable body of pure air at a temperature ten to fifteen degrees higher than that of the air near the floor; hence, if a certain amount of outside air can be mixed with this to bring the temperature down to 68 or 70 degrees, it will gradually fall to the breathing level, and thus, by proportioning the outside air supply to the surplus heat given off by the radiators, a very marked improvement in the purity of the air may be obtained.

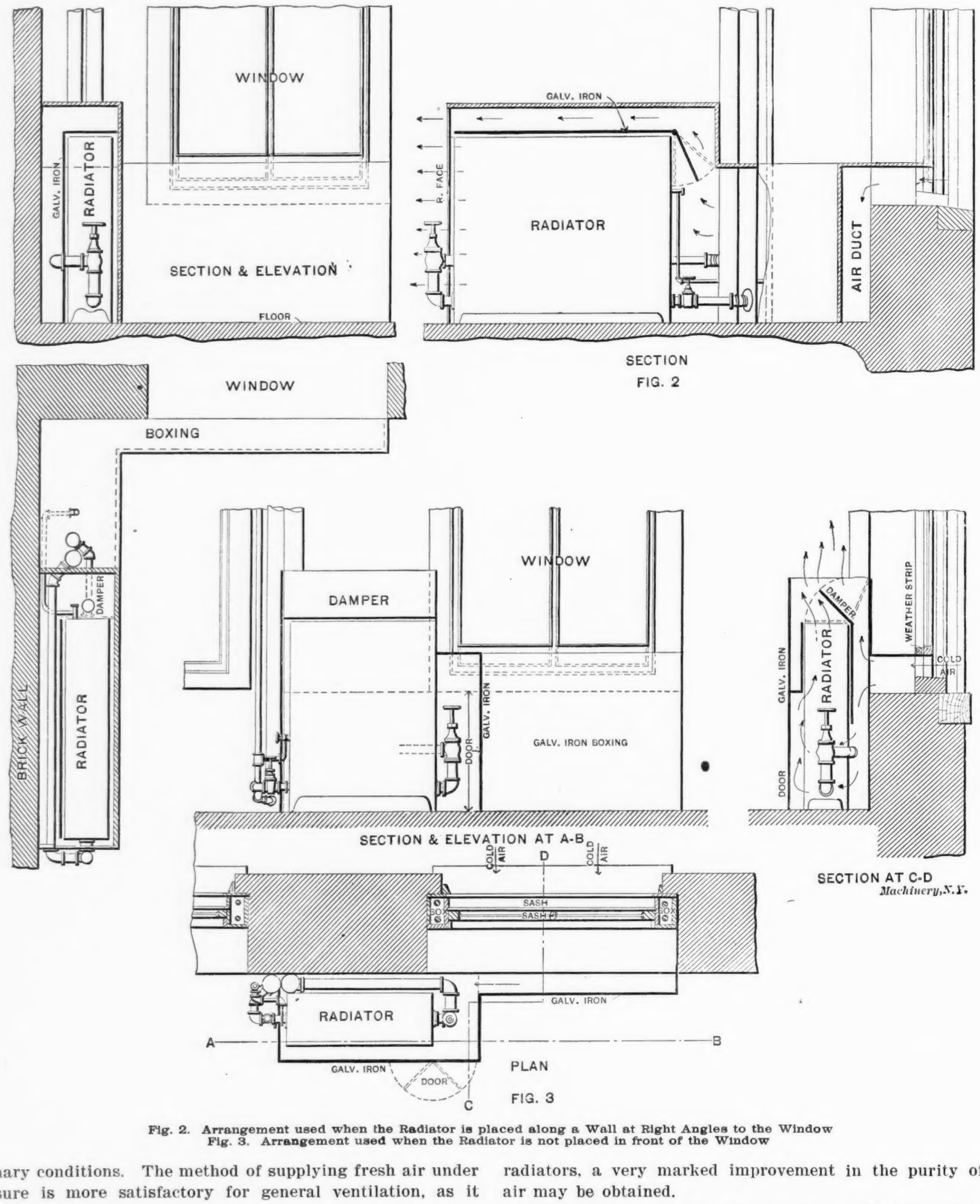


Fig. 2. Arrangement used when the Radiator is placed along a Wall at Right Angles to the Window
Fig. 3. Arrangement used when the Radiator is not placed in front of the Window

The apparatus consists of an ordinary desk fan placed in a wooden boxing so arranged as to draw outside air from the top of a window, the upper sash being dropped slightly, and to discharge it in a thin fan-like sheet near the ceiling. The object of this is to thoroughly mix it with the warm air of the room before it has a chance to fall in the form of a cold draft. Narrow registers, with cords for opening and closing from the floor, are placed in each side of the boxing around the fan, as shown. When the cold air supply is too great,

and drafts are felt, the sash may be partially closed and the side registers opened slightly, as may be required. In this way the cold air is reduced and part of the supply is drawn from the room and recirculated. This, of course, reduces the ventilation, but the volume of fresh air must be sacrificed rather than to allow the presence of cool drafts. A 12-inch desk fan run on the medium speed will answer very well for a room containing from 6 to 8 people. The diffuser opening may be about 4 inches in depth by 4 feet in length, the object being to secure a thorough mixing of the air.

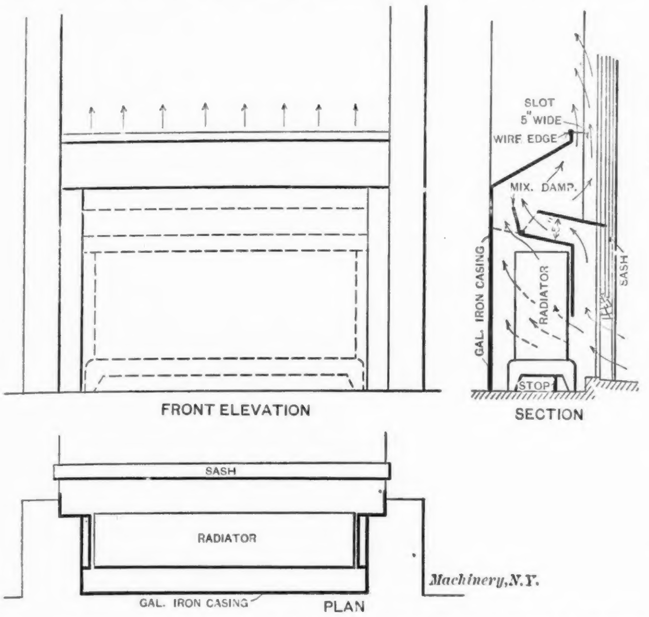


Fig. 4. Radiator placed in front of the Window, in a Niche in Thick Brick Wall

A better arrangement, though more expensive, is shown in Fig. 6. This is adapted to the ventilation of several rooms by extending the distributing duct from the fans by means of suitable branches. The apparatus is hung from the ceiling at some convenient point in the shop, as shown in Fig. 7, and takes its air from the upper part of a near-by window. The air is warmed by means of a special heater made up of pin radiators, and divided into three or four separately-valved sections for regulating the quantity of heat as required at different seasons of the year. Close regulation for varying the temperature of the air during different parts of the day is secured by the use of a mixing damper which "by-passes" a part of the air through a separate passage under the heater, where it mixes with the hot air just before it enters the fan.

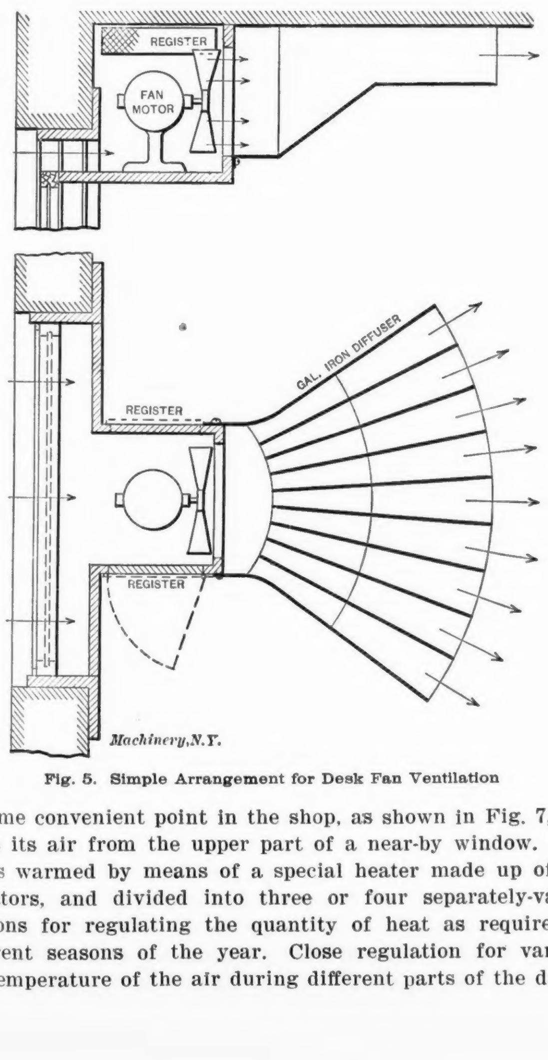


Fig. 5. Simple Arrangement for Desk Fan Ventilation

An important point in an arrangement of this kind is to keep the cold air by-pass entirely separate, as shown in the section in Fig. 6, so that the air will not be warmed to any extent while being drawn past the heater. Otherwise it will be difficult to secure a sufficiently low temperature in mild weather. The mixing damper may be operated by hand, being adjustable, so that it can be set in any desired position. A better arrangement is to use one of the systems of automatic control, with a "graduated" mixing damper, as by this means the apparatus requires no particular attention after the thermostat is once set.

This type of apparatus is more especially adapted to cases where the rooms are heated by direct radiation, and the air supplied at a temperature of 68 or 70 degrees, for ventilation only. The heater can be made of sufficient size to both ventilate and warm the rooms if desired, although if the space to be warmed is of considerable extent, it is more common to use the outfit shown in Fig. 8, simply because it is more compact. If the heater in Fig. 6 is used for ventilation only, a "hot-air" thermostat should be placed in the duct and set to maintain an air temperature of 68 or 70 degrees. If the heater is proportioned to warm the rooms as well, a "room" thermostat should be used instead, this being placed upon an inner wall of the room. In case the air is to be delivered at a fixed temperature for ventilation only, a dial thermometer should be placed in the side of the air duct at some convenient point beyond the fan. This is necessary for setting and adjusting the thermostat if automatic control is used, and for operating the hand mixing damper in other cases. When the apparatus is used for heating also, all adjustments of thermostat and damper are done by means of an ordinary wall thermometer, which indicates the temperature of the room. The fan shown in this case is of the disk type, driven by a direct-connected motor. If more convenient, a belted high-speed motor may be used, or the fan may be driven from a convenient countershaft. High-speed motors are not usually objectionable about a shop, as quietness of operation is not of great importance in locations of this kind.

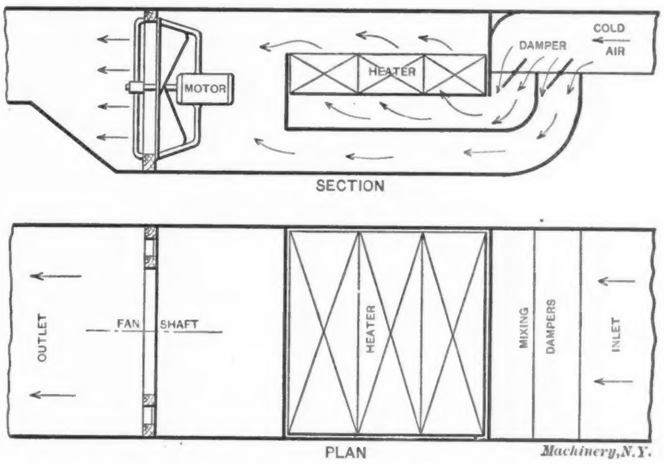


Fig. 6. Arrangement for Ventilating with Heated Air, or for both Heating and Ventilation

The computations for determining the size of fan and heater are simple. The air supply should be based on 2,400 to 3,000 cubic feet per occupant per hour, which allows a small margin for overcrowding at times without inconvenience. The square feet of surface in the heater for ventilation may be computed by the equation

$$S = \frac{O \times C \times 1.3}{1{,}500} \qquad (1)$$

in which

S = square feet of radiating surface,

O = number of occupants,

C = cubic feet of air per hour per occupant = 2,400 to 3,000.

When the heater is used for warming the rooms in addition to ventilation, the following may be used:

$$S = \frac{(O \times C \times 1.3) + T}{1{,}000} \quad (2)$$

in which S, O, and C are the same as in (1), and T = the total heat loss from the rooms in heat units per hour. The value of T in average cases may be found by multiplying the glass surface by 90, the net wall surface by 20, adding the results, and multiplying by the following factors, according to exposure:

TABLE I

Exposure	Factor	Exposure	Factor
North	1.32	Northwest	1.26
East	1.12	Southwest	1.10
South	1.0	Northeast	1.22
West	1.20	Southeast	1.06

The size and speed for the average disk fan and the horsepower of motor is given below.

TABLE II

Diam. of Fan, Inches	Revolutions per Minute	Cubic Feet of Air per Minute	Horsepower of Motor
18	530	1,000	0.08
21	450	1,400	0.09
24	400	1,800	0.12
30	320	2,900	0.18
36	270	4,200	0.25

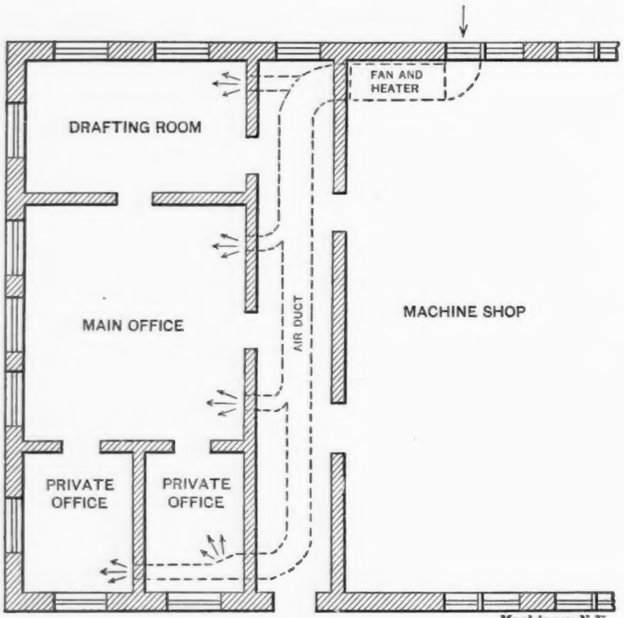


Fig. 7. Plan of Offices with Apparatus shown in Detail in Fig. 6 installed

Example: The offices and drafting-room in a shop contain an average of 36 people; there are 300 square feet of window surface and 600 square feet of wall surface. The exposure is west. What will be the size and speed of disk fan, and horsepower of motor to drive it? Also, how many square feet of pin radiation will be required.

We have $36 \times 3{,}000 \div 60 = 1{,}800$ cubic feet of air required per minute, which from Table II calls for a 24-inch fan running at 400 revolutions per minute and requires 0.12 horsepower to drive it. The square feet of surface in the heater is found by substituting the known quantities in equation (2); the first step is to find the value of T,

$$\begin{aligned} &(\text{glass})\ 300 \times 90 = 27{,}000 \\ &(\text{wall})\ 600 \times 20 = 12{,}000 \\ \hline &\qquad 39{,}000 \times 1.20 = 46{,}800. \end{aligned}$$

Substituting in the equation, we have

$$S = \frac{(36 \times 3{,}000 \times 1.3) + 46{,}800}{1{,}000} = 187.$$

Fig. 8 shows an outfit which may be used in the same way as the one just described, when it is desired to have the apparatus as compact as possible. In this case a blower of the steel plate type is used instead of a disk fan, and a pipe heater of the regular hot-blast type takes the place of the pin radiators. This apparatus may be supported upon a platform or upon I-beams suspended from the ceiling or roof of the shop. The same idea regarding air-ways and mixing damper as in the arrangement shown in Fig. 6, is carried out here. The deflector in front of the heater prevents the air from being drawn directly across the hot pipes when the mixing damper is set for all, or nearly all, cool air. The mixing damper shown is for hand manipulation. In case the automatic arrangement is employed, the double damper shown in Fig. 6 should be used.

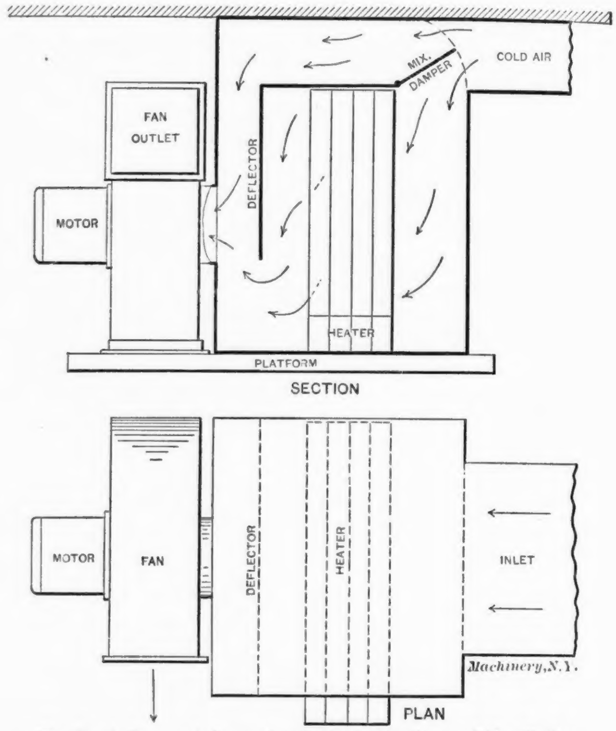


Fig. 8. A Compact Apparatus for both Heating and Ventilation

Pipe heaters for ventilation only should be 6 or 8 pipes deep, and the square feet of heating surface may be computed by equation (1) by substituting 1,800 for 1,500 in the denominator of the second member. When used for heating as well as ventilating, the heater should be from 12 to 14 pipes deep, and the surface computed by equation (2), substituting 1,200 for 1,000 in the denominator. In all of the computations for heaters it has been assumed that steam at a pressure of about 5 pounds would be used.

The piping for a heater of the hot-blast type is shown in Fig. 9. The special point brought out here is the method of making the return connections from the different sections with the main return. Each separate return in this case is sealed against the others by a siphon loop to prevent the condensation from backing from one into the other, which is apt to occur if this precaution is not taken to prevent it. As the coldest air strikes the outer sections, condensation is more rapid and the pressure is slightly less tnan in the inner ones; hence the necessity of sealing the returns. As the pressure in the return main is always slightly higher than in the heater, owing to the drip connection with the supply main, it is necessary to make the legs connecting with the heater longer than the others, as the highest column of water is always in this side of the loop.

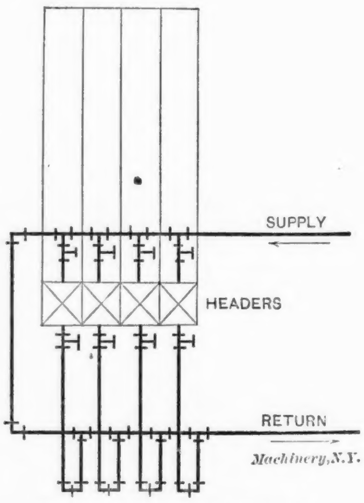


Fig. 9. Piping for a Heater of the Hot Blast Type

Of equal importance with the fan and heater is the method of distributing and discharging the air to get the best results without perceptible drafts. Fig. 10 shows an outlet for delivering air from the side of a duct where diffuser blades are

used for spreading the air as it enters the room. An adjustable deflector is provided to catch the desired amount of air it is desired to deliver at each outlet. Fig. 11 shows a diffuser outlet and adjusting damper for use when the air is discharged at the end of a branch instead of from the side of a duct as in Fig. 10.

When the main shop is heated by a hot-blast system taking all, or a considerable portion of its air from out-of-doors, an

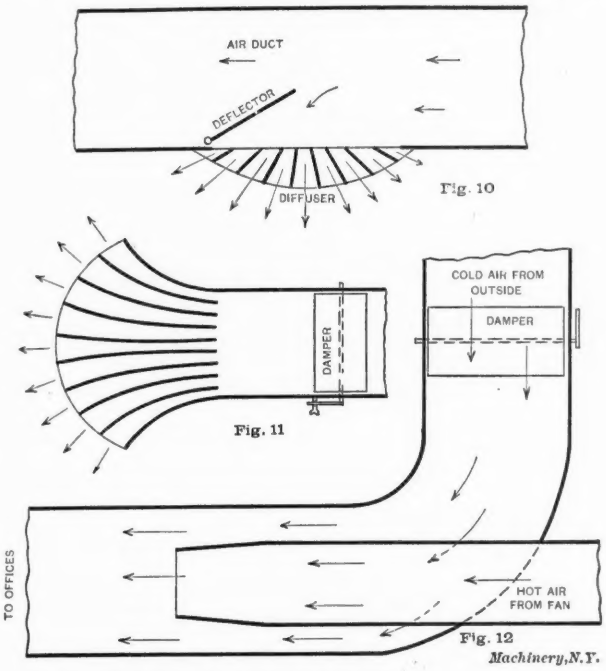


Fig. 10. Outlet for Hot Air from Side of Duct. Fig. 11. Diffuser Outlet and Adjusting Damper for End of Branch Duct. Fig. 12. Injector Arrangement for Mixing Hot and Cold Air

"injector" arrangement like that shown in Fig. 12 may be used for mixing a certain amount of cold outside air with the hot air from the fan, when the temperature of the rooms becomes too high. In this way the temperature may be lowered without reducing the air supply; instead, it will be increased, because the amount of hot air will remain the same while a certain amount of outside air has been added for cooling it. Fig. 13 shows the way of connecting the outside air supply to the "injector." It is well to make this connection some distance back from the outlets to the rooms, in order to give an opportunity for a thorough mixture of the air before reaching the rooms. The amount of cool air required can be regulated by means of a damper.

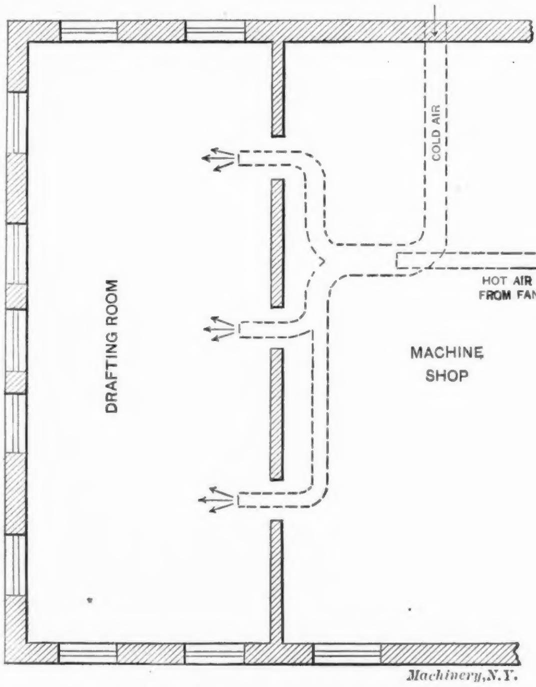


Fig. 13. Method of Connecting the Outside Air Supply to the Injector shown in Detail in Fig. 12

The size and speed of the blower type fan and the horsepower of motor, can be obtained from Table III, which has been computed for this class of work.

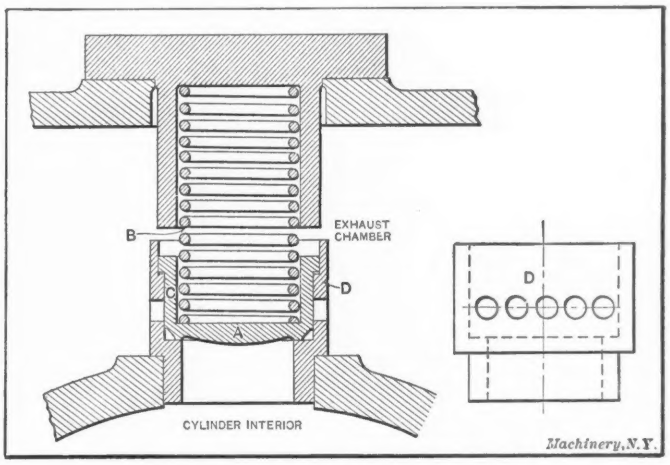
TABLE III

Diam. of Fan Wheel, Inches	Revolutions per Minute	Cubic Feet of Air per Minute	Horsepower of Motor
30	540	3,600	1.6
36	450	5,000	2.0
42	380	7,000	3.0
48	330	8,600	3.7
54	300	11,000	4.5
60	270	13,500	5.5
72	240	16,500	6.8

* * *

RELIEF VALVE FOR STEAM ENGINE CYLINDERS

The pop safety valve now almost universally used on American locomotive and marine boilers and largely on stationary boilers rapidly reduces the boiler pressure when it "blows off." The construction of the valve is such that the area effectively exposed to steam pressure is considerably increased when the valve lifts, the steam having to escape past the lip of the valve through an opening technically known as a "stricture." This increase of effective pressure overcomes the spring pressure, sufficiently to open the valve wide and permit the steam to escape freely. When the pressure has reduced a few pounds, the valve closes as suddenly as it opened, the effective pressure being as quickly reduced as it was



Bollinckx Improved Relief Valve for Cylinders

increased. The quick and positive action rapidly lowers the boiler pressure and also reduces the deterioration of the valve seats to a minimum because of reducing the time of blowing off and the cutting action of steam blowing through a partially opened valve. The pop valve is either open or closed whereas the ordinary safety valve sputters, blows, again sputters and slowly closes leaving perhaps a slight leak to cut away the valve bearing.

An analogous construction is employed in an improved form of steam cylinder relief valve devised by H. Bollinckx, steam engine builder, Brussels, Belgium, to prevent hammering of the valve on the seat. Ordinary relief valves give trouble by hammering on their seats if adjusted closely to the maximum compression allowed. In the Bollinckx design it will be observed that the valve is made in the form of a piston *C* closely fitting the cage *D*. Through the sides of the cage are holes communicating with the exhaust chamber. The valve *A* has a flat seat of the ordinary form outside of which it is beveled off, thus forming an annular cavity. In order to relieve the pressure, the valve must lift from its seat sufficiently to permit the steam or water to escape through the ports in the side of the cage *D*. If the valve lifts and falls rapidly, it cannot pound the seat because the steam trapped in the annular cavity cushions it, deadening the shock.

* * *

Five miles of the Panama Canal have been opened to navigation. This includes the channel from the point in the Bay of Panama where the water is 45 feet deep at mean tide to the wharf at Balboa. Steamships are using this part of the canal daily.

INTERESTING TOOLS AND METHODS OF CINCINNATI SHOPS–3

THE G. A. GRAY CO.

ETHAN VIALL*

Of the many interesting shops of Cincinnati, not one is more interesting than that of the G. A. Gray Co.; and yet

Fig. 1. Blocks placed in Clapper-boxes in Different Positions to show Accuracy of Fitting

there is none more difficult to adequately describe, for it is not so much the machines and devices one sees there as it is the methods and workmanship, which are above the ordinary. Huge planer parts weighing thousands of pounds are machine

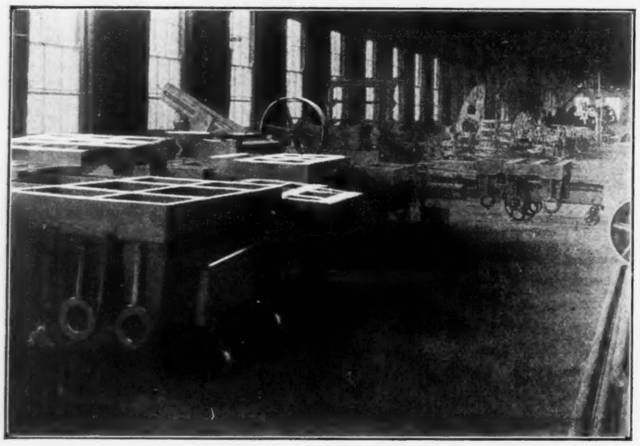


Fig. 3. Planer Bed Boring Jigs and Trucks on which they are stored

finished, and with absolutely no hand work are made as interchangeable as the parts of a watch. This seems almost impossible, and only a personal visit to this shop can really convince one. Of course the absolute interchangeability of parts

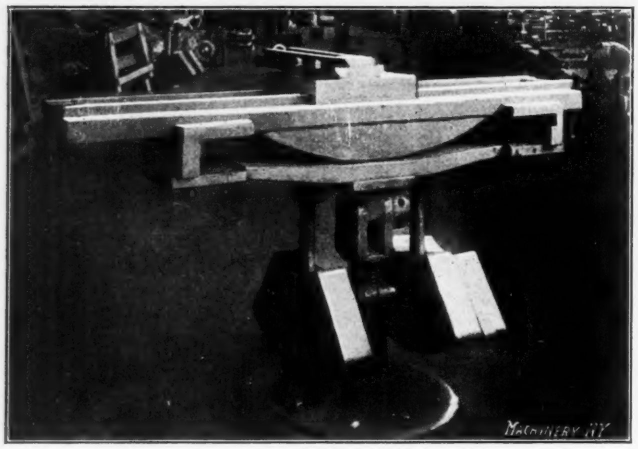


Fig. 5. Universal Stand to hold Crossrails when fitting the Slides

is a very desirable feature for any class of machines, for as a rule, the average shop whether large or small, pays out more money in the erecting or assembling department than in any other single department just because of the immense amount of hand fitting, scraping and filing that must be done in order to make the alleged interchangeable parts go together. On very small or medium-sized parts the problem is not so difficult as it is on large work, yet that large parts weighing hundreds or thousands of pounds each can be made interchangeable, is an absolute fact and this too without any scraping or other hand work whatever. In other words, parts may be so finished in a machine that one or a hundred will

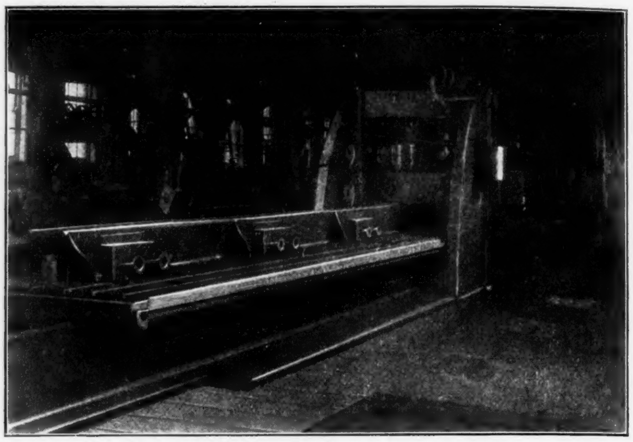


Fig. 2. Planing Four Small Planer Beds on a 34-foot Planer

fit into its appointed place with perfect accuracy.

Naturally, judging from the foregoing, anyone can see that the G. A. Gray Co. does not rush the work through the shop at the rate of sixty miles an hour and then put on an extra

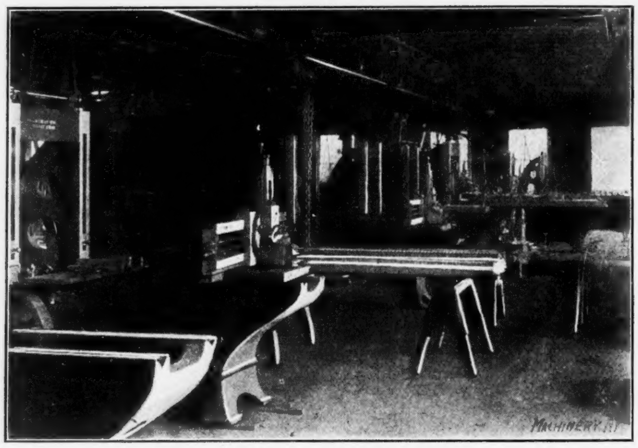


Fig. 4. Crossrail Assembling Room

force of men in order to get it through the assembling department before the Panama Canal is finished.

In the shop, twenty-three planers are in constant use, which gives the firm a chance to test the machines which are built,

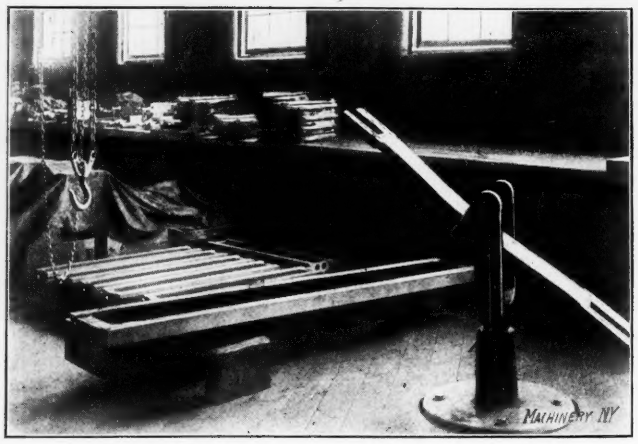


Fig. 6. Stand for Holding Rails while Scraping the Ends

under every conceivable condition. As the company owns its own foundry, the proper metal for each part is secured—hard, close-grained iron for parts subject to wear and tough iron for those under strain and liable to fracture—and so it is evident that the importance of the foundry, as well as the machine shop, is appreciated.

* Associate Editor of MACHINERY.

Briefly glancing at a few of the points in the Gray planer construction, we find that the driving gears and racks are made of a special semi-steel mixture, which tests 44 per cent more than cast iron. All rail and feed screws are of 50 point, and shafts of 55 to 60 point carbon, hammered crucible steel. Driving shafts run in solid cast iron bushings accurately ground, and set into holes correctly located and bored directly into the bed of the planer, and the holes in bushings, gears and pulleys, as well as all holes for feed rods and the like are reamed to plug gages. Any parts which are reamed too large are scrapped, and not fitted with a special bushing or part. Keys are milled to snap gage sizes, instead of using cold rolled stock filed to approximate fits. Keyways are milled to standard sizes in an automatic machine, built for this purpose. All cylindrical parts are ground. The housings are made absolutely square with no provision whatever for shims to make a "Dutch fit."

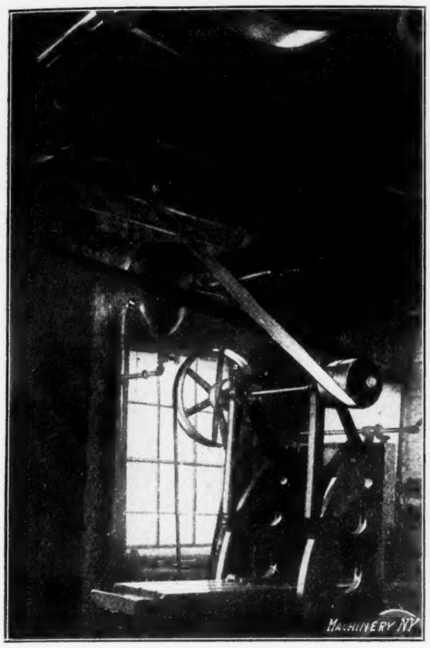


Fig. 7. Special Countershaft Brackets fitted to Planer Housings

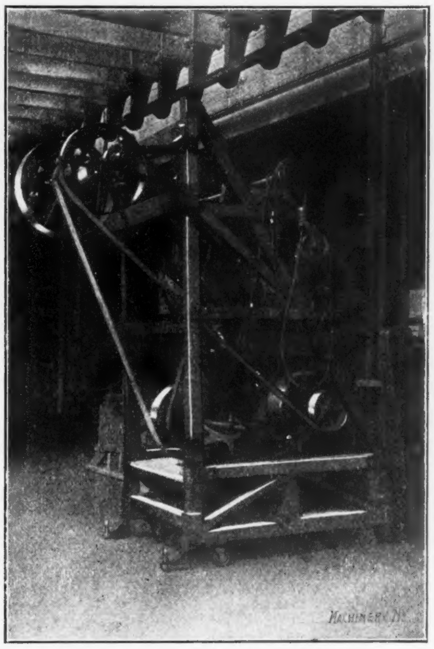


Fig. 8. Portable Motor-driven Countershaft for Testing

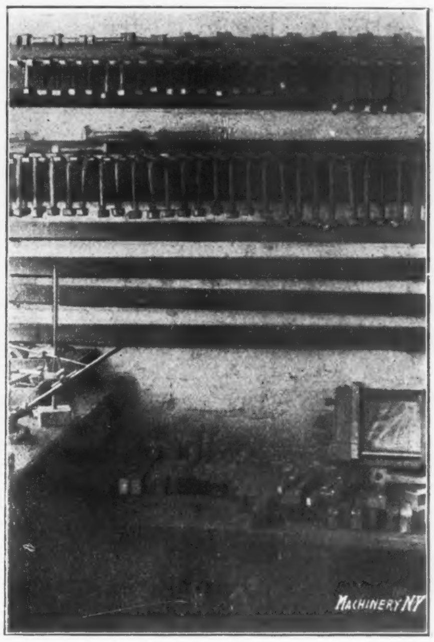


Fig. 9. Planer Operator's Corner showing Bolt-racks and Tools

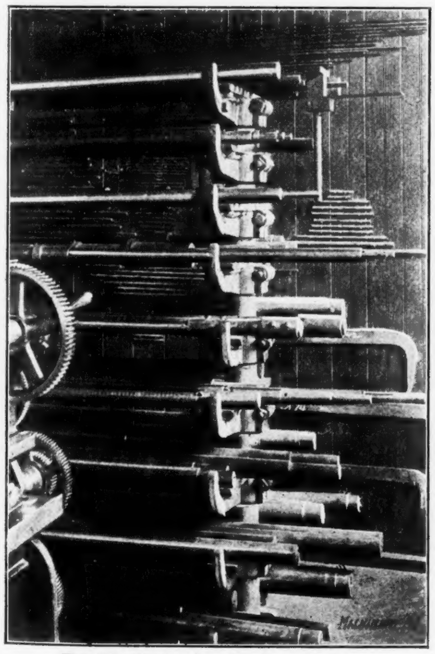


Fig. 10. Boring-bar Racks and Cages

I could go on indefinitely enumerating the points picked up during my visit, but the above must suffice for the present; there is one very important thing, however, that is often overlooked by users which is that besides being made right, a planer must be leveled up properly where it is to be run, and kept so. In order to make this leveling or testing as simple as possible, the four top surfaces of the V's are planed perfectly true at the same setting in which the V's themselves are planed, so that a level may be applied directly on top of them; therefore it isn't necessary to hunt for round bars of the same size to lay in the V's before using a level.

Nothing that I saw in the shop impressed me more, as regards accurate workmanship, than an inspection of a pile of clapper boxes and tool-blocks. Out of perhaps a hundred, I selected four at random and placed the blocks in a different position in each one. The parts had not been touched by a scraper—or anything but a planer tool—and were just as they came from the machine; yet absolutely no difference could be detected in the fit, no matter in what position the block was placed in the box. The fit was close enough to hold the blocks suspended at any point, yet a push of the fingers easily carried them to the bottom, and the fit of any one block was as good in one apron as in another. The four clapper boxes with the blocks in four different positions are shown in Fig. 1. At *A* the block is shown high in the box; *B* shows it turned end for end; *C* shows it bottom side up with the ends in the right direction, while *D* shows it bottom side up but turned in the opposite direction.

In Fig. 2 are shown four small planer beds being planed at once on a 34-foot planer with a 62-foot bed. When a planer bed is finished, no mark of any kind is put on it to indicate which end is to be toward the front of the machine, as it will fit just as perfectly one way as the other on any machine of its size, and this, too, with no scraping except the broad cross scraping, which is done to harden the surface and to remove the "loose metal" left by the planer tools, which, if it were not removed, would soon cut out the bearing.

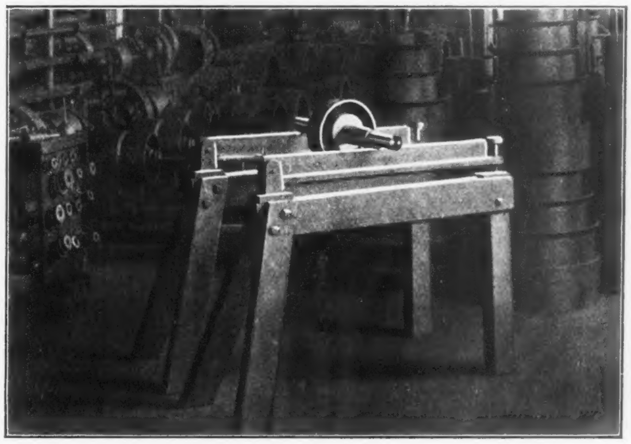


Fig. 11. Iron Ways on which Pulleys are balanced

The various jigs used for accurately locating the different holes in planer beds, and the special trucks on which they are kept, are shown in Fig. 3. This method of storing makes the handling of these heavy jigs a very easy matter.

A view of the department in which the crossrails and their fittings are put onto the housings is shown in Fig. 4, and in Fig. 5 is shown a balanced, universal scraping stand for cross-

rails and slides, these being among the parts that have to be drilled and tapped after planing and, consequently, are liable to be sprung by these subsequent operations, and so must be corrected by scraping. In mounting the cross rails on the stands, they are held in practically the same way as when bolted to the housings, in order to eliminate the error which might result were they clamped to the stand one way and bolted to the planer in another.

Fig. 6 is a stand used for finishing the ends of rails.

Fig. 7 shows the way a planer has been fitted with a special countershaft mounted on brackets bolted to the housings, in order to belt to the lineshaft without interfering with some low steam pipes.

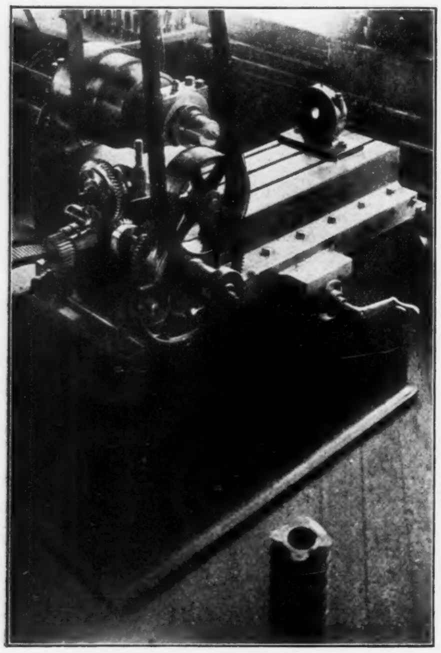


Fig. 12. Special Machine for Milling Spirals

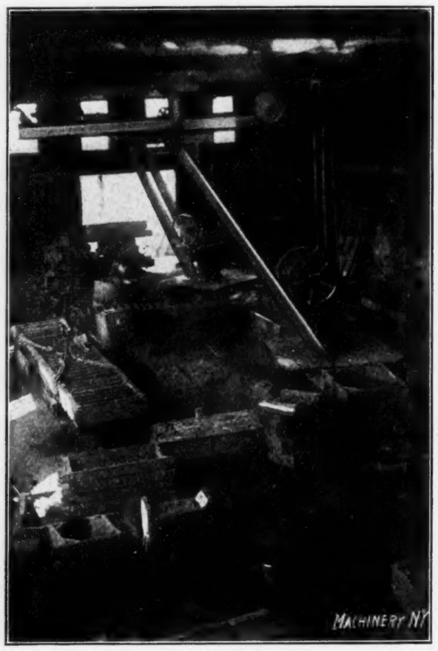


Fig. 13. View of Foundry Showing Crane Arrangement

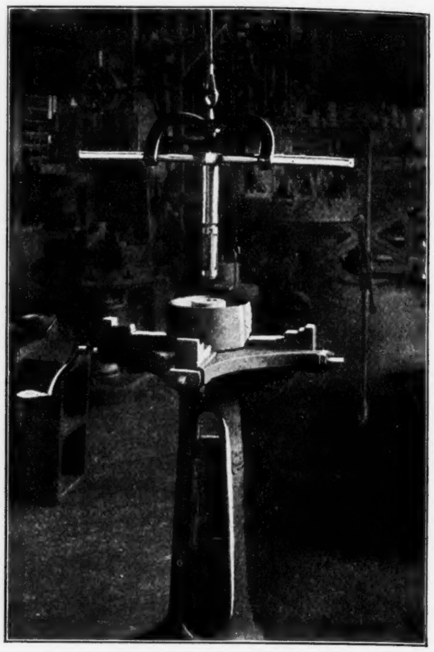


Fig. 14. Pulley Chucking Machine and Reaming Device

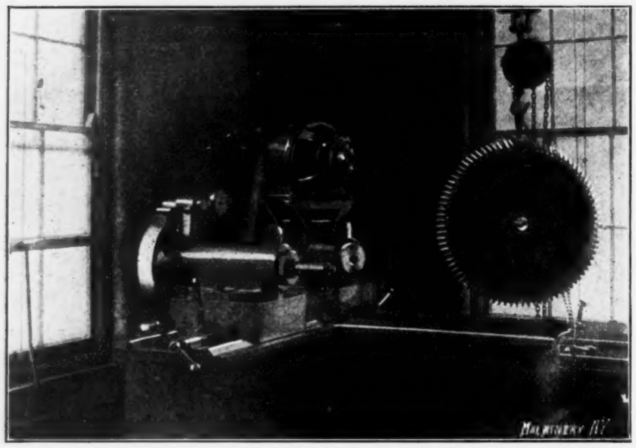


Fig. 15. Universal Motor-driven Gear-testing Machine

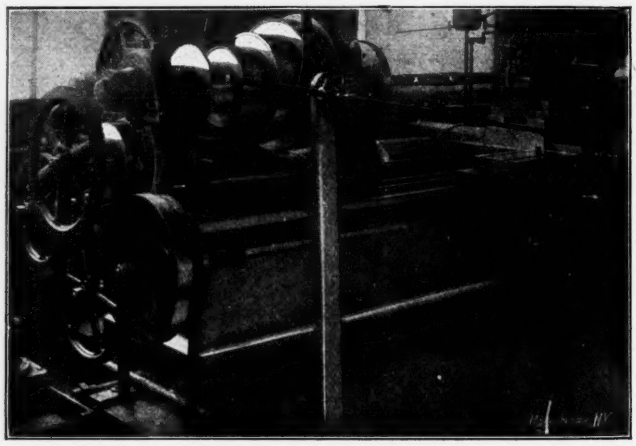


Fig. 16. Lathe driven by Pulley on Lead-screw when Cutting Spiral Grooves

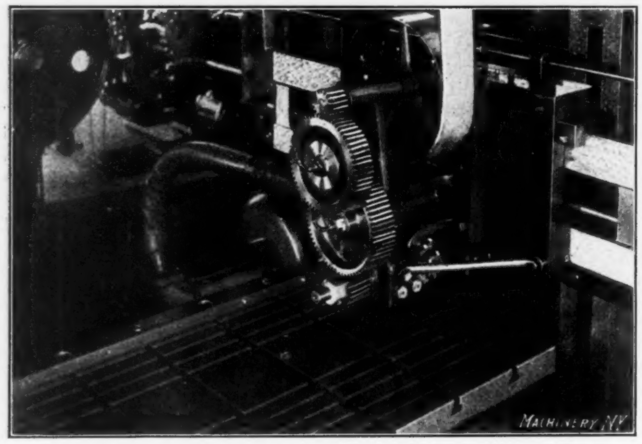


Fig. 17. Rack Milling Machine with Individual Chip Exhaust Fan

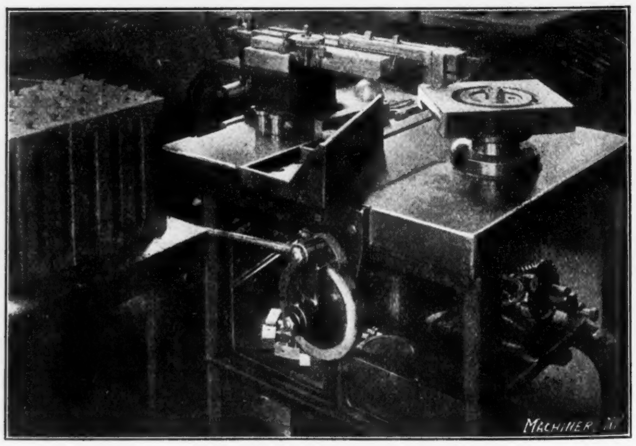


Fig. 18. Automatic Graduating Machine

Fig. 8 is a portable motor-driven countershaft used for trying out planers on the testing floor. By using this countershaft, a planer may be tested anywhere it may be placed.

A planer man's corner with its tools and neat bolt rack is shown in Fig. 9, and in Fig. 10 is shown the racks used in the toolroom to hold the big boring-bars, reamers and other heavy bar tools, while on the wall are some of the large inside and outside gages.

The spirals used for spiral geared planers are milled on a special extra-heavy milling machine (Fig. 12) built for this purpose only. The gears are cut from the solid with a formed end mill, first being roughed out and then allowed to "season" before finishing.

Fig. 13 is a view of the foundry taken just after an unusually busy period, and shows the convenient crane system used.

Pulleys are held in the chucking stand (Fig. 14), and the holes carefully reamed to size with an adjustable reamer suspended from a counterbalanced bracket as shown. All pulleys are carefully balanced on the three-legged balancing ways (Fig. 11) which are made, legs and all, of iron, the V's being adjustable so as to be easily leveled.

Fig. 19. Nut Grinding Fixture and Arbors used

Spur gears are cut on Brown & Sharpe automatic gear cutters, and bevel gears are planed on a special gear planer. To insure the perfect running of all these gears, they are tested

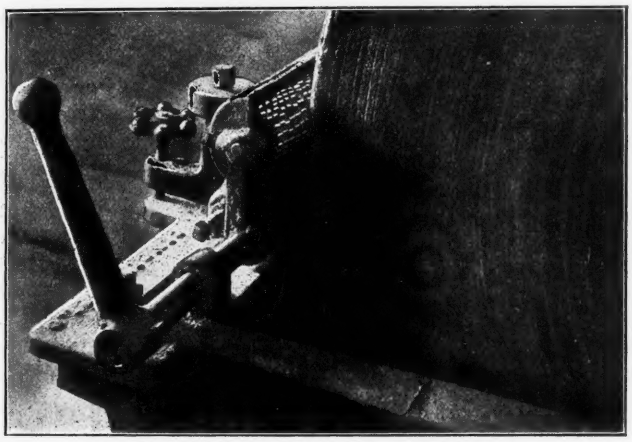


Fig. 20. Tool for Truing the Grindstone

on the special machine shown in Fig. 15, which is operated by a variable speed motor which permits the gears being run at any speed desired. The machine is equipped with dou-

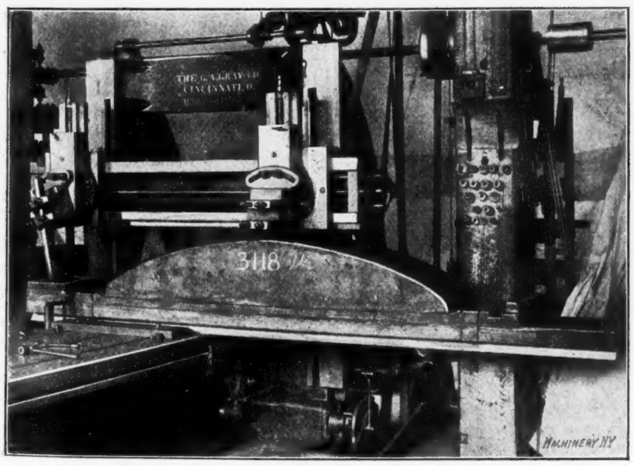


Fig. 21. Planing the End of a Large Crossrail

ble brakes, so that the gears can be run under resistance in either direction. The spindles carrying the gears to be tested can be set at any angle with each other. When tested in this way, it is definitely known that gears will run properly, not only on machines being erected, but also on any which may need repairs.

All driving shafts are chased with spiral oil grooves in the lathe shown in Fig. 16, which, owing to the great lead of the spiral, is not driven from the cone pulley on the spindle, as usual, but from a pulley placed on the lead-screw as shown, thus doing away with the abnormal strain that the gears would otherwise be under. For convenience, the machine, when used for cutting oil grooves, is driven from below by a belt running through the floor, the shifter being arranged as shown. The oil holes for these shafts are not drilled at random as is generally the case, but are all jigged.

Some of the small racks are milled, and this is done on a machine which is fitted with an individual exhaust fan, as shown in Fig. 17.

Mistakes in graduating on a milling machine are so frequent where a considerable amount of this work has to be done, that some sort of an automatic machine is almost a necessity, so the one shown in Fig. 18 has been built for this work. The piece to be graduated is first set at the proper angle so that the marking may begin at the right place, by means of a sliding angle-plate, after which it is tightened on the indexing spindle and the angle-plate is drawn back out of the way. The long and short lines are automatically spaced by means of a cam-wheel with one long and four short

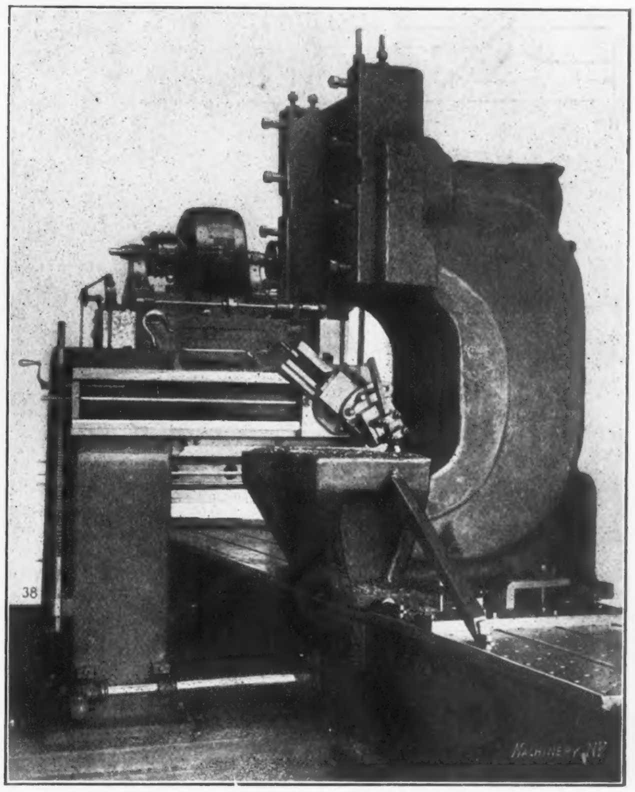


Fig. 22. Planing the Lower Jaw of a 16,000 pound Shear Casting

rises, and the marks are *rolled* in instead of cut, which forces the material into the pores of the metal and insures perfectly sharp, true dividing lines of equal depth, without tearing.

Nuts are ground on the bottom true with the tapped hole, so that they will bear evenly and not be under a side strain, by placing them top first on compensating arbors like *A* or *B*, Fig. 19, which are held in the spindle of the grinding fixture *C*, which is made to fit the regular grinder table.

The big grindstones in the shop are kept true by using the patented truing device which is plainly shown in Fig. 20.

Several jobs of more than passing interest have been done at the Gray shop at different times, one of the jobs being the planing of the lower jaw of a huge shear weighing 16,000 pounds. The independent housing shown in Fig. 22 was used. Fig. 21 illustrates the difficult feat of planing the end of a big 3,118-pound crossrail in which the great overhang and short stroke made the job one to test the capabilities of any planer, both in the rigidity of the table and the reliability of the reversing mechanism.

* * *

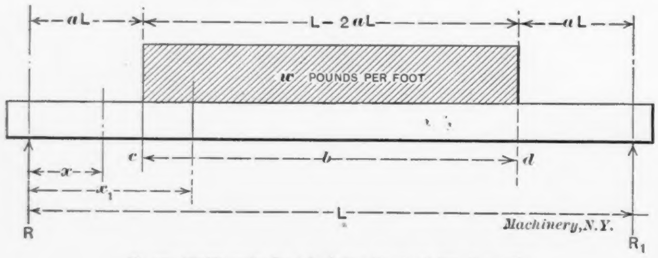
Don't try to make a motor pick up its load too quickly, or before it gets up to its speed.

DEFLECTION OF BEAM UNIFORMLY LOADED FOR PART OF ITS LENGTH

GEO. E. BARRETT*

A recent problem in design involved the calculation of the deflection of a simple beam uniformly loaded for part of its length, as illustrated, and a careful search was made of all the hand-books, American as well as foreign, and of the text-books available that could throw any light on the subject, but no formula was found from which the maximum deflection could be computed, so the next step was to deduce one. At first, it was thought that the result would be too complicated and too long for practical consideration, but, as a matter of fact, the formula is not difficult to handle, especially with a table of logarithms, and then the fact that accurate results can be found without resorting to an approximate method ought to commend its use.

Referring to the engraving, the load is symmetrical and uniformly distributed for a distance b with an intensity of w



Beam Uniformly Loaded for Part of its Length

pounds per foot. Let the distance from each reaction R and R_1 to the load be aL, where a is less than unity.

$$R = R_1 = \frac{w\,(L - 2\,aL)}{2} = \frac{wL\,(1 - 2a)}{2} \qquad (1)$$

For any distance x between the left reaction and c the bending moment will be

$$Rx. \qquad (2)$$

For any distance x_1 between c and d, the bending moment will be

$$Rx_1 - \frac{w\,(x_1 - aL)^2}{2} = Rx_1 - \frac{1}{2}wx_1^2 + waLx_1 + \frac{1}{2}wa^2L^2 \qquad (3)$$

The well-known equation for the elastic curve $EI\dfrac{d^2y}{dx^2} = M$, where E equals the modulus of elasticity of the material used, I, the moment of inertia of the section, and M, the bending moment at any distance x or x_1, can be now used to deduce an expression for the deflection.

Between R and c

$$EI\frac{d^2y}{dx^2} = Rx. \text{ See formula (2)} \qquad (4)$$

$$EI\frac{dy}{dx} = \frac{1}{2}Rx^2 + C \qquad (5)$$

$$EIy = \frac{1}{6}Rx^3 + Cx + C_1 \qquad (6)$$

Between c and d

$$EI\frac{d^2y}{dx^2} = Rx_1 - \frac{1}{2}wx_1^2 + waLx_1 - \frac{1}{2}wa^2L^2 \qquad (7)$$

See formula (3)

$$EI\frac{dy}{dx} = \frac{1}{2}Rx_1^2 - \frac{1}{6}wx_1^3 + \frac{1}{2}waLx_1^2 - \frac{1}{2}wa^2L^2x_1 + C_2 \qquad (8)$$

$$EIy = \frac{1}{6}Rx_1^3 - \frac{1}{24}wx_1^4 + \frac{1}{6}waLx_1^3 - \frac{1}{4}wa^2L^2x_1^2 + C_2x_1 + C_3 \qquad (9)$$

y in (6) $= o$ when $x = o$; then $C_1 = o$.

$\dfrac{dy}{dx}$ in (8) $= o$ when $x_1 = \dfrac{L}{2}$; then $C_2 = \dfrac{1}{48}wL^3 - \dfrac{1}{8}RL^2 - \dfrac{1}{8}waL^3 + \dfrac{1}{4}wa^2L^3$

Formula (5) $=$ (8) when $x = x_1 = aL$; this will give a value of

$$C = -\frac{1}{6}wa^3L^3 + \frac{1}{48}wL^3 - \frac{1}{8}RL^2 - \frac{1}{8}waL^3 + \frac{1}{4}wa^2L^3$$

Substituting this value of C in (6) gives the following expression for the deflection of the beam for any position between R and c.

$$EIy = \frac{1}{6}Rx^3 - \frac{1}{6}wa^3L^3x + \frac{1}{48}wL^3x - \frac{1}{8}RL^2x - \frac{1}{8}waL^3x + \frac{1}{4}wa^2L^3x.$$

Formula (6) $=$ (9) when $x = x_1 = aL$; substituting this value for x and x_1 in (6) and (9) and placing them equal to each other gives a value for C_3 of $-\dfrac{1}{24}wa^4L^4$. The maximum value for y will occur when $x_1 = \dfrac{L}{2}$. Substituting this value for x_1 and the value obtained for C_3, in (9) give

$$EIf = \frac{wL^4}{384}(-5 + 24\,a^2 - 16\,a^4)$$

where f is the maximum deflection. Substituting for w, the expression for total weight W is

$$EIf = \frac{WL^3}{384\,(1 - 2\,a)}(5 - 24\,a^2 + 16\,a^4)$$

$$f = \frac{WL^3}{EI\,384\,(1 - 2\,a)}(5 - 24\,a^2 + 16\,a^4) \qquad (10)$$

The expression for maximum bending moment is

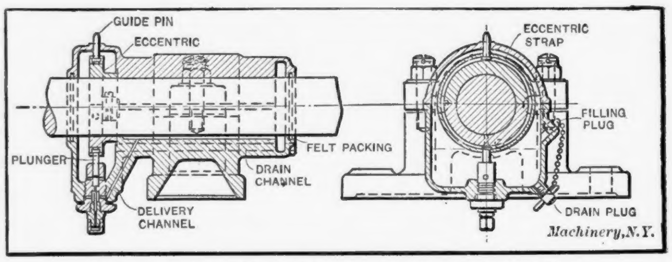
$$M_{max} = \frac{1}{8}WL\,(1 + 2\,a) \qquad (11)$$

* * *

BEARING WITH SELF-CONTAINED OIL PUMP

JOSEPH G. HORNER*

A new automatic forced lubrication system is being introduced for bearings of various kinds by Messrs. Vickers, Sons & Maxim, Ltd., who have several works in England devoted to various manufactures. The novelty is that the pump



Bearing with Automatic Oil Pump for Forced Lubrication

is enclosed in the bearing in an oil chamber at one end, and is driven by the rotation of the shaft so that the volume of lubricant varies with the demands made upon it. An eccentric (see the illustration) mounted on the shaft within the chamber drives the pump plunger which delivers the oil up through a sloping channel to the under side of the shaft where it is mostly required. The waste oil collects in a drain channel and returns to the chamber. The pump plunger has a stroke of about 5/16 inch, with a diameter of about 3/8 inch. In general the eccentric is surrounded with a strap the action of which is positive on both strokes, but in some cases the strap is dispensed with and the plunger is forced downward by the eccentric and returned by a coiled spring. In another modification for axle-boxes, a tube is carried from the pump to the top of the bearing to lubricate the pad there. In others a row of pumps actuated by one shaft supplies oil to multiple sight-feed lubricators for engine parts.

[The principle of the automatic oil pump arrangement is the same as that illustrated and described in MACHINERY, Dec., 1906, in an item entitled: "A Shafting Hanger With Forced Lubrication."—Editor.]

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MAKING HEAVY CHAIN AND ANCHORS FOR UNCLE SAM

CHESTER L. LUCAS*

"In time of peace prepare for war" is an old adage that seems to be especially heeded by the great naval powers of the world. Forward strides have been made in methods of naval warfare, and the achievements in building battleships and their equipments have been little short of marvelous. One of the primary requisites of a battleship is speed, and while we hear much of the results along this line, little has been said of the modern methods that are employed for anchoring and holding in check these valuable warships; for it must be remembered that a battleship can go to destruction as quickly on a reef as under the enemy's fire. Realizing the importance of this factor, the United States government has a well-equipped department at the Charlestown Navy Yard wherein every link of chain and every anchor used in the navy is made. Through the courtesy of Commander H. E. Parmenter, MACHINERY's representative was allowed to photograph and record the various processes and machinery used in chain and anchor making.

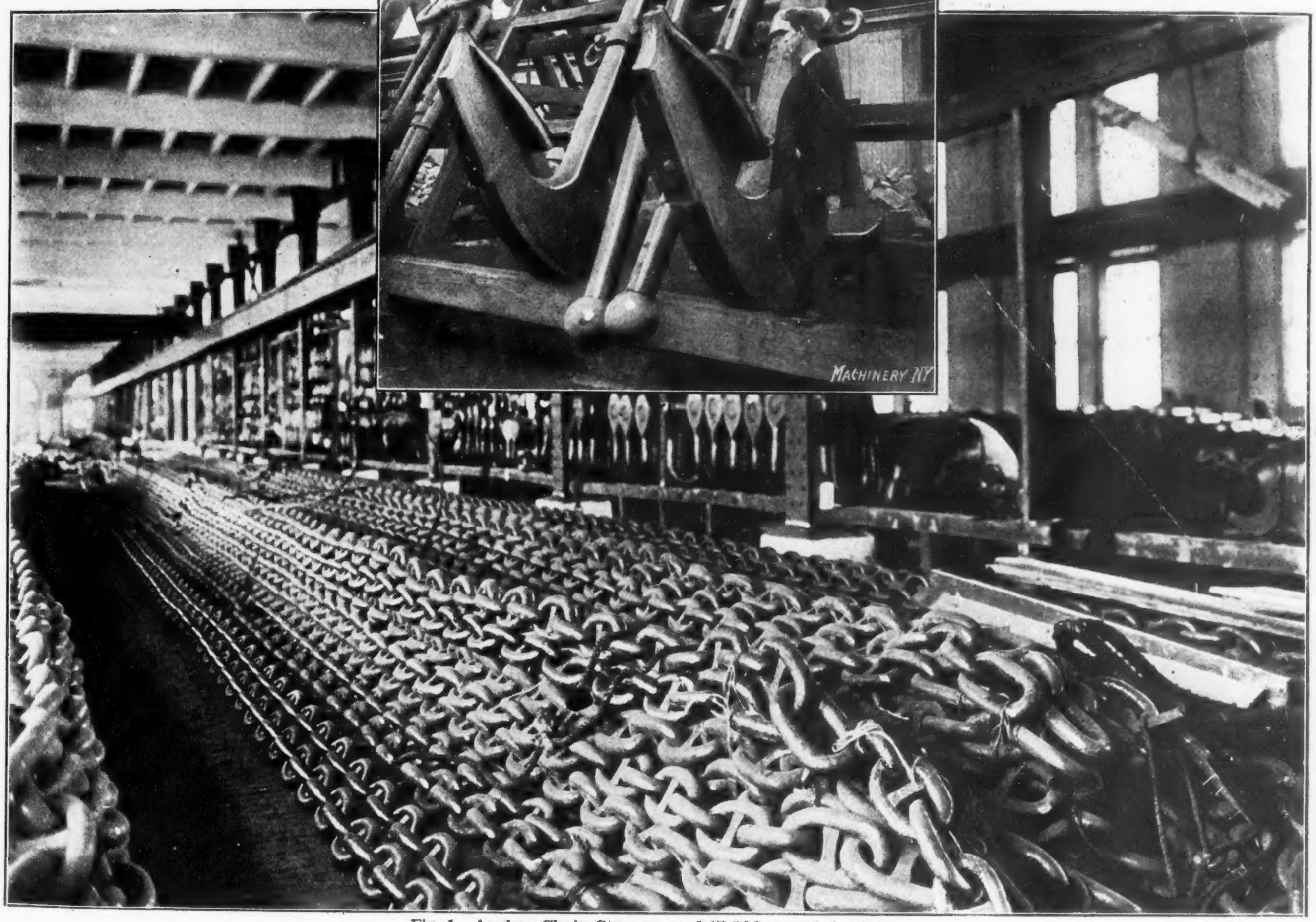

Fig. 1. Anchor Chain Storage, and 17,500 pound Anchors

The Iron

But one make and one quality of iron is used for the heavy chains in the navy, and by heavy chains are meant those with links made of bars from 2½ inches to 3¼ inches in diameter. This iron comes from one of the best makers in Pennsylvania, and is received in square muck-bars 1⅞ inch in diameter. It is accepted only after passing the rigid physical and chemical tests imposed by the government. One requirement of the chemical test is that the percentages of sulphur and phosphorus be very low. By getting the iron in the muck-bar, it is assured that the metal has received the lowest number of heats possible before the chain-smiths of the navy yard begin to work it.

Rolling the Bars

The first step in making the heavy chain, taking for example the 2½-inch size, is to cut the muck-bars to lengths of about 2 feet, the cutting being done cold by means of large alligator shears. These short lengths are then wired into bundles of about 25 each. As these bundles weigh from 250 to 300 pounds, they are handled with crane-tongs and in this manner slid into the huge furnaces. From the furnaces these white hot billets are passed to the rolls and converted into bars of the required diameter—in this case 2½ inches. Fig. 2 shows a view of the rolling department of the chain shop with the furnaces on the left and the rolls on the right. The chain shop is in charge of Mr. William Kelley. In front of the furnaces may be seen piles of cut muck-bars ready to be bundled for the furnace. During the rolling operation, two men stand on each side of the rolls, which, similar to other machines for rolling bar stock, are made with a set of breaking-down grooves and three or four smaller sets leading down to the finishing grooves, which are of the size of the finished bar. A third set of men haul the white hot billet from the furnace and with crane tongs rush it to the breaking-down rolls. To successfully start the billet through the first set of grooves is the hardest part of the rolling, but as this set of grooves is made with short, cleat-like teeth, the metal is sent through without much trouble. Fig. 3 shows the starting of a white hot billet. If the iron starts to slip, a handful of sand is thrown in and the slipping tendency overcome. After the iron has gone through the breaking-down grooves it is passed back over the rolls and entered in the next set. As the metal is passed through the smaller grooves in the rolls it is, of course, stretched to a greater length, and after the last set has been passed the bar is ten feet long, and the rolling time has been so short that the iron is still at a bright red heat.

Cutting and Bending

From the rolls it is but a few steps to the hot-saw which cuts the bars to the proper lengths for the links. The hot-

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saw itself is about 4 feet in diameter and travels with a peripheral speed of 20,000 feet. At a 30-degree angle to the saw is set the table, which is provided with a vise to grip the bar while cutting. The table is set level with the floor, so there is no unnecessary handling of the hot bars. The purpose of cutting the iron bars at a 30-degree angle is to provide for the scarf, so essential to welding. Some idea of the capacity of this saw may be obtained when it is realized that a 30-degree cut through a 2½-inch bar (a cut 5 inches long) is made in 4 seconds.

The two machines shown in Fig. 6 are for bending the links. They are very simple but ingenious machines, and they form the links much better and in a fraction of the time that it would take to do it by hand. Both of these machines were designed by Commander Parmenter and made in the machine shops of the Charlestown Navy Yard under his supervision. The smaller machine is for chain made from 2½-inch stock, while the larger one takes stock from 2¾ inches to 3⅛ inches. The action of the machine, which is in reality a press, is very simple and easily understood. The forming

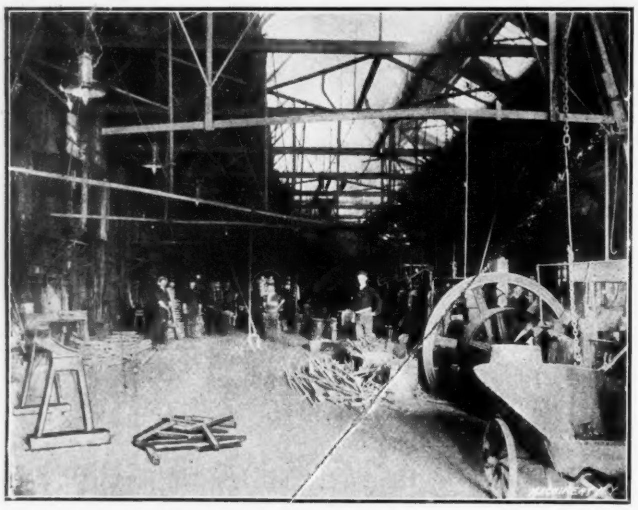


Fig. 2. Generel View of the Chain Shop

arbor, shaped like the inside of the link, is located just inside of the oval opening at the front of the machine. The groove around this arbor is spiral, so that as the iron is bent to the shape of the link, the ends will be separated enough to allow the links to be connected before welding. On either side of the central opening may be seen the two cam grooves that guide the forming rolls that bend the link. The bar from which the link is to be made is inserted at the left-hand side of the press; the ram descends, carrying the forming rolls (which are mounted in slides to provide for lateral movement)

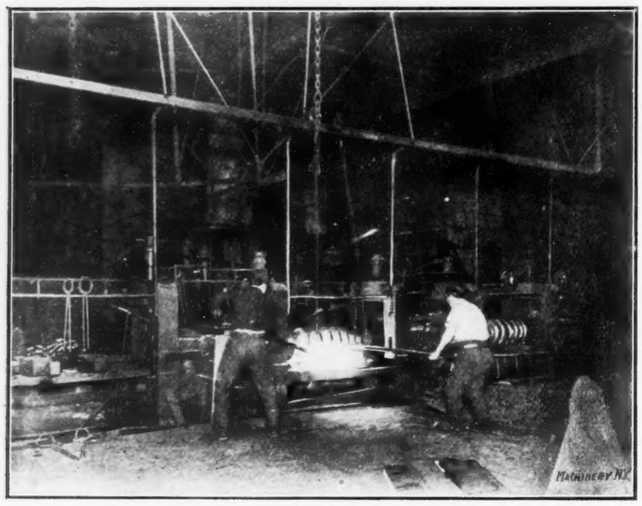


Fig. 3. Starting a White-hot Billet through the Rolls

down the grooves, thus giving the link-shaped motion that does the forming. After the link is bent, the arbor recedes, allowing the link to drop to the opening at the base of the machine. All of these operations of rolling, sawing and bending, from the time the billet leaves the furnace for the first time, are performed in one heat and when the link drops from the bending machine it is still at a good red heat.

Welding and Testing

In the welding department there are about a dozen fires with their "chain-gangs" for welding the links. These fires

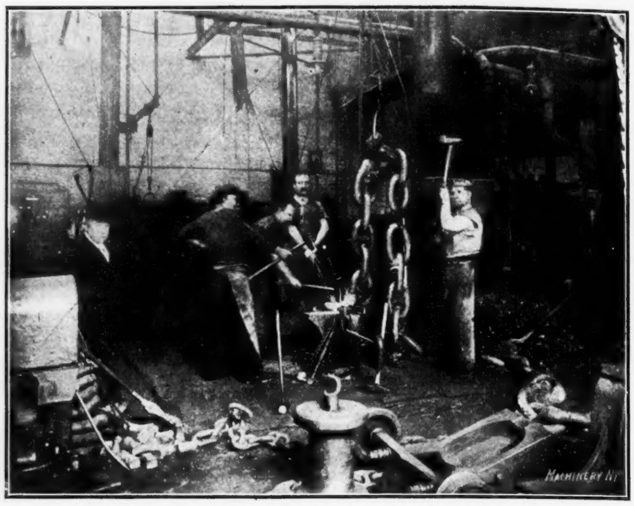


Fig. 4. The Chain Gang at Work Welding a Link

use coke for fuel, and at the side of each one is a constantly growing chain of completed links. Fig. 4 shows one of these fires with its crew at work welding a link. For some of the chain a welding machine is employed, but most of the work is done as shown in the illustration. After connecting the uncompleted link to the rest of the chain, the slack of the finished chain is pulled up out of the way by the hoist shown and the link to be welded is bent together. Next, the joint is placed in the fire and heated without heating the rest of the chain any more than can be helped. When the welding heat

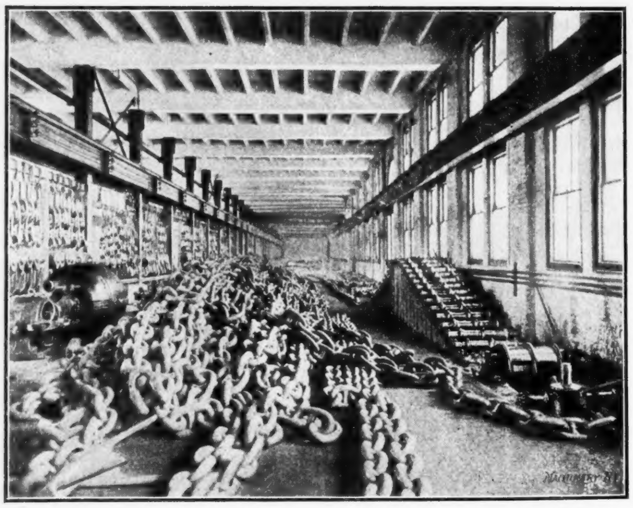


Fig. 5. Chain Painting Apparatus and Chain Ready for Painting

is reached, the link is quickly transferred to the anvil and the strikers send in the blows, under the direction of the smith, who handles the link. The rapidity with which this welding is done is surprising, considering the fact that the chain has "a string tied to it" that makes it awkward to handle. After welding, a drop-forged block is placed in the center of the link and the sides of the link closed in upon it, holding it firmly in place. Each block has the letters "U. S. N." raised upon each of its sides, and while this block does not add to the strength of the chain,* it has a purpose, which is to prevent the chain from kinking and catching while stored away in the hold of the battleship.

* According to Unwin the British Admiralty rule for the proof test of studded cable chain is: Test load in tons (2,240 pounds) = 18 d^2, corresponding to a load of about 11½ tons per square inch of section. For close-link crane chain without studs it is: Test load in tons = 12 d^2. The stud chain thus is subjected to a proof load 50 per cent greater than close-link chain. However, tests made both abroad and by the Boston Navy Yard have shown that the stud does not add to the ultimate strength but rather detracts from it. The function of the stud is essentially to insure the chain running freely from the chain lockers and prevent it becoming rigid under heavy strains.—EDITOR.

Testing and Finishing

The testing apparatus used to prove the quality of the chain is very powerful and the result is conclusive. Owing to the location, it was impossible to obtain a good photograph of the apparatus. The chain is placed in a steel-lined pit, 100 feet long, 3 feet wide and 3 feet deep while under test. A length of chain 90 feet long is made fast at one end of the pit and the other end attached to the testing machine. With this machine it is possible to subject the chain to a strain of 80,000 pounds, this being accomplished by using hydraulic pressure. From each length of chain three links (called a triplet) are taken and tested to destruction. This test proves the chain beyond all doubt, and no poor or weak link can possibly "get by."

At the end of the testing pit there is a steel subway that leads to the storehouse on the other side of the street. A thirty horsepower winch furnishes the power for pulling the chain through the subway. Fig. 5 shows a view of one side of the storehouse, with a pile of chain waiting to be painted. At the right-hand side of the engraving may be seen the device that is employed for painting the chain. Just under the drum in the foreground is the paint tank. The paint, which is black asphaltum, is kept hot by the steam pipes running through the tank. The chain is passed through the tank and

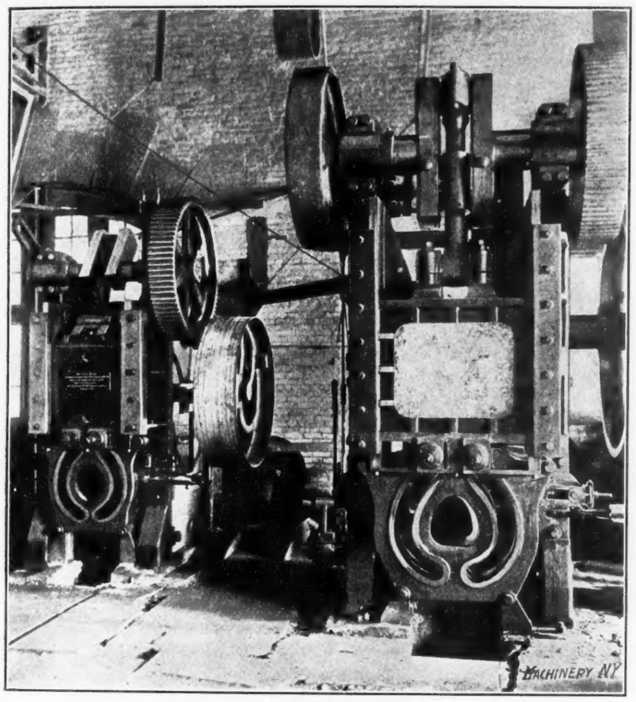


Fig. 6. The Link Forging Machines

under the steel drum and then over the inclined rollers. Another thirty horsepower winch at the farther end of the building is used to draw the chain through the tank and over the rollers. As the paint is applied hot and the chain is drawn over the rollers very slowly, the paint is dry by the time the chain leaves the apparatus. The other side of the chain storehouse is shown in Fig. 1. This view shows more clearly the blocks in the links. Here again the floor is literally lined with chain, and one would think that there was chain enough made to last the navy for years, but when it is remembered that the life of a chain is limited, being scrapped as soon as re-testing proves it to have lost its elasticity or to be otherwise defective, it can be easily seen that Uncle Sam's chain-making industry is an important one.

Anchor Making

The anchor shop of the United States Navy is located in the same large building as the chain shop, and while it is not as large a department, it is fully as important. The work is in charge of Mr. William Paul, whose experience in this line is without a doubt unequaled in this country.

Material and Equipment

In this shop are forged all the anchors for the navy. They vary in size from 400 pounds to 17,500 pounds. The material from which anchors are made is simply the scrap from the process of chain-making—imperfect links, short ends, etc. Fig. 7 shows a pile of this waste chain iron ready to be made into anchors. At the anchor shop it is made into billets of sufficient size to make the various anchor parts. These rough masses of iron are held and worked on huge porter bars, which for the large anchors are 6 inches in diameter and about 12 feet long. The furnaces are of the same type as those

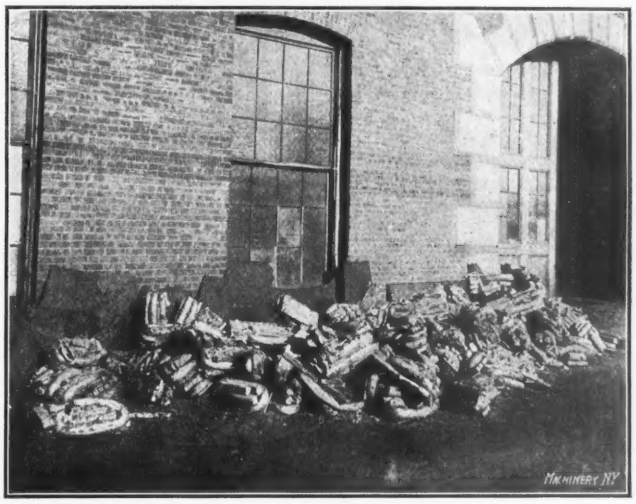


Fig. 7. A Pile of Scrap Chain from which Anchors are made

used in the chain shop, burning soft coal for fuel. Oil furnaces have been tried, but were discontinued for reasons of economy. The steam hammers—and there are six or eight of them—range up to twenty horsepower on the large work.

The Anchor and its Parts

As has been intimated, anchors are built up of several parts, each of which is forged at different fires, according to the size of the work. The parts of an anchor are the two palms, the crown, the shank, the stock and the shackle. The stock and the shackle are not parts of the main anchor forging, though they are very essential to the proper working of the anchor. The stock is to insure the anchor falling in such a position as to grip firmly, and the shackle is the connecting link for attaching the chain. Referring to Fig. 8, *A* is the shank, *B* the crown, *C* the stock, *D* the shackle, and *E E* are the palms. The palms, however, are only called by that name before they are welded to the crown. In the completed anchor, the ends of the crown with the attached palms are known as the flukes.

The System of Forging

In everything that Uncle Sam does there is a common underlying factor that enters into every detail. That factor is system, and it is right at home in the anchor shop as well as in the chain shop. A small model anchor with correct proportions has been made and from that model the weights and measurements for the various sizes of anchors have been computed. Each anchor, then, has its standard size and weight, which is a great aid to the blacksmith. The palms, as forged, are merely flat pieces, triangular in shape and quite thin. The shank is forged with a flat end to be welded to the crown, and holes are forged in the top end for the stock and shackle. The crown is forged with a recess to receive the end of the shank when making the box weld. Through the ends of

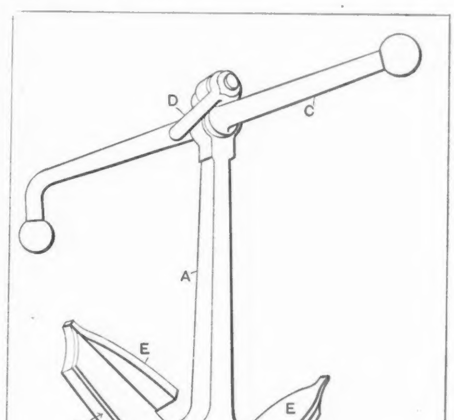


Fig. 8. The Anchor and its Parts

the crown are two holes which are used to hold it to the porter-bar while it is being shaped and welded to the shank. After the anchor is finished, the holes are extended through the palms and a large rivet put through and headed over. This rivet serves no purpose other than to improve the looks, unless it be to keep the elements from the interior of the iron. A glance at the anchors shown in Fig. 9 illustrates this point. At first thought it is natural to think that the rivet helps to hold the palm to the crown, but as these two parts are united by a weld it is plain that the rivets cannot add to the strength. After the forging of the crown and shank is

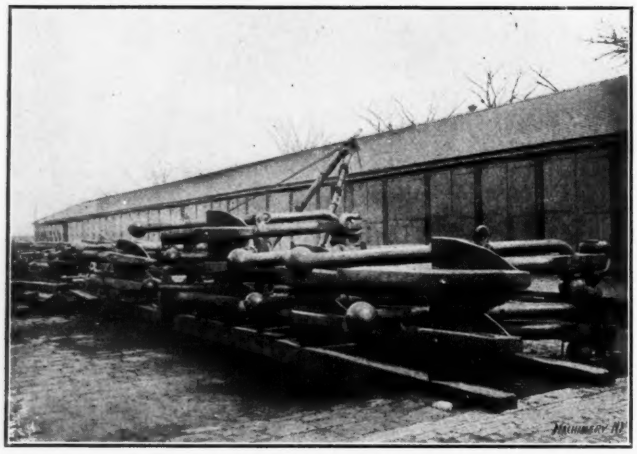


Fig. 9. A Pile of 3- and 5-ton Anchors

finished, they are heated in separate fires and box welded together. The anchor is now complete except for the stock and shackle. These parts are not added until the last thing. The stock is a plain forging and needs no comment. In putting the balls on the ends of the stock, it is, of course, necessary to leave one of the balls off until the stock is put through the anchor, after which the ball may be headed over. The shackles for the small and medium-sized anchors are forged in quantity. These shackles are made from round bars of the size of the body of the shackle, the ends being upset to form the eye. The holes in the eyes and the shaft that enters the

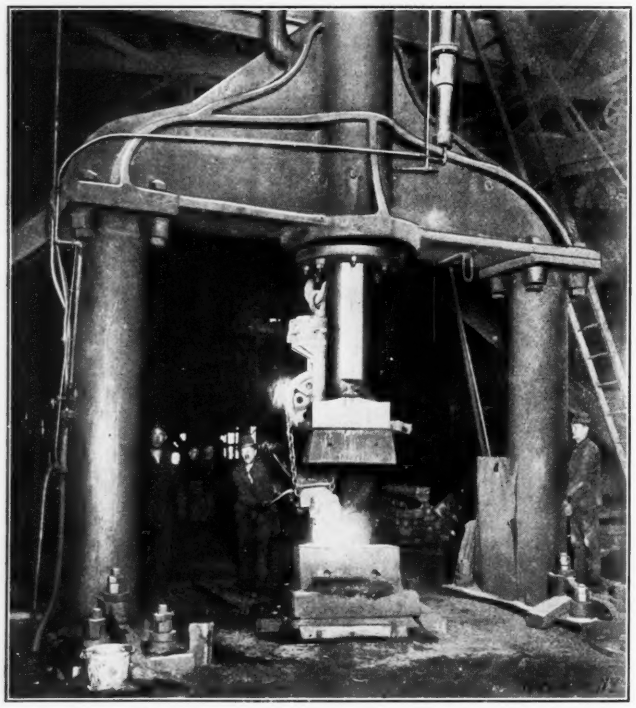


Fig. 10. Forging an Anchor Crown under a 20-ton Steam Hammer

holes are slightly oval so that they may be easily assembled correctly. The shaft is held in place by a taper key, called the fore-lock pin. To bend these shackles and still keep the iron up to its full size, was a problem that Commander Parmenter solved very neatly. The tendency is for the iron to stretch and so flatten out around the bend, thus materially weakening the shackle. He designed a simple and powerful bender that presses the ends of the piece hard up towards the bending point while the shackle is being bent at the same time, thus supplying the extra stock necessary to make a full bend. Fig. 10 shows the 20-ton steam hammer at work putting the finishing touches on one of the flukes of a medium-sized anchor. In this case, as the anchor is not a very heavy one, the crown is being held by the crane and guided by using large tongs instead of the porter-bar used on the larger work.

Costs and Accuracy of Anchor Forging

While the description of anchor forging is not a lengthy one, the work of making a 17,500 pound anchor takes a number of men 27 working days. As the material in the shape of crude iron costs in the neighborhood of eighty dollars a ton and the men receive from three to five dollars a day, it is not hard to realize that the cost of one of these large anchors runs up into four figures.

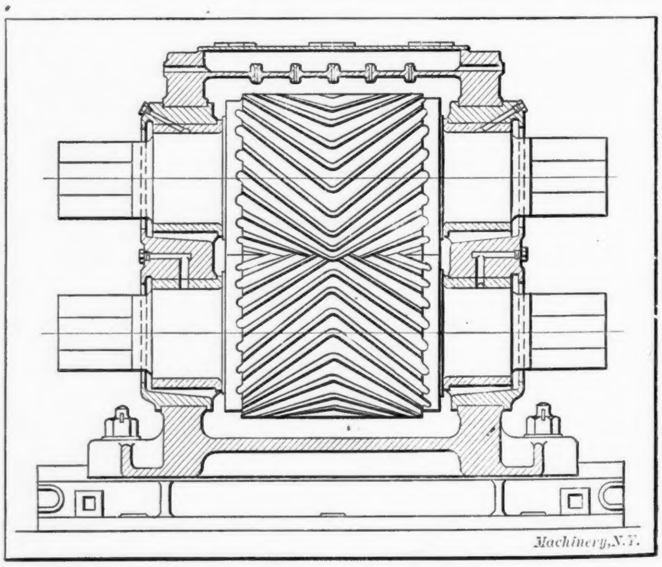
Fig. 9 shows some finished anchors weighing from 6,000 to 10,000 pounds. The two anchors shown in the upper part of Fig. 1 weigh 17,500 pounds each. As the battleships are constantly increasing in size with every new model, the anchors and chain must keep pace (a 20,000-pound anchor is under consideration at the present time), so it is hard to say when the limit will be reached. Upon each anchor the actual weight is stamped in large figures. A few of these figures were copied off as follows: 17,550, 10,030, 9,080, 10,040, 6,004, 5,975. As these anchors were made for 17,500, 10,000, 10,000, 10,000, 6,000, 6,000 pound anchors, respectively, the figures show how closely the work is done, a fact due to the system of proportional sizes that is so closely adhered to by Uncle Sam's experienced anchorsmiths.

* * *

DOUBLE HELICAL CUT PINIONS FOR ROLLING MILLS

JOSEPH G. HORNER*

The steel pinions which drive the rolls of rolling mills have hitherto usually been cast in molds made by tooth-blocks in a gear wheel molding machine. Messrs. P. R. Jackson & Co., Ltd., of Salford, Manchester, England, who are probably the largest manufacturers of cast gears in England, have now constructed a plant for cutting the teeth of rolling mill pinions of double-helical forms, or straight when required. It follows that such gears must be en-



Machine-cut Double Helical Rolling Mill Pinion in Enclosing Housing

closed in an oil box in order to secure the fullest efficiency and durability. They are, therefore, fitted in enclosed housings with oil supply tank above as shown in the accompanying illustration. The advantages of smooth running, reduced blacklash, and greater durability, should more than compensate for the higher first cost of these gears over ordinary cast pinions.

* * *

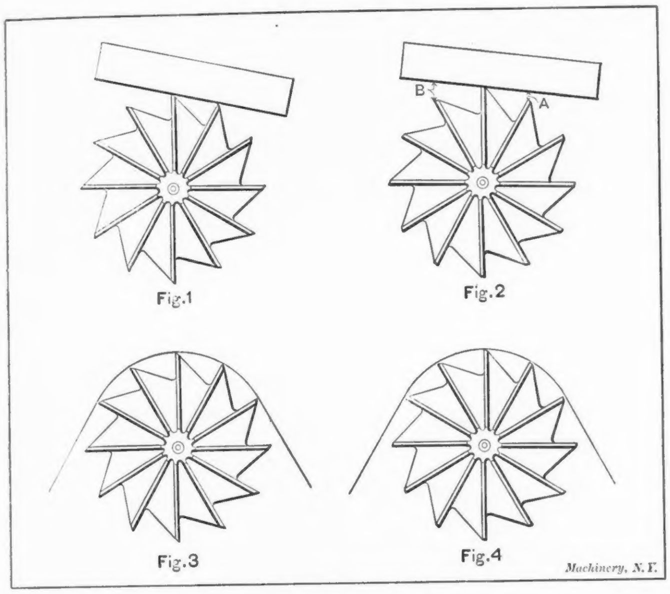
Blue ink lines on tracings seldom show up clearly on blueprints, but if a quantity of orange ink is mixed with the blue the line is made opaque.

* Address: 45, Sydney Buildings, Bath, England.

EXPERIENCES OF A YOUNG TOOLMAKER*

T. COVEY

On reporting to his foreman that the surfacing mills were ready to be hardened, Jim was told that his next job would be to grind up the end mills that he had made. Mr. Corbin took him to the grinding room and showed him the machine that he was to use to grind the shanks, and sent him to get the same gage that he used in turning the shanks. On his return Mr. Corbin said, "Whenever you are setting up a grinder for a job like this, you should keep the wheel well away from the work until you are sure that the stops that trip and reverse the traverse feed of the wheel are properly set, as otherwise the wheel is liable to run into a shoulder on the work or the footstock of the machine and either break the wheel, or damage the work or the center; and, *never run a large wheel that has no guard over it.* Now to grind tapers on this machine, loosen the clamps at the end of the table and swing the table around in the proper direction by means of this adjusting screw. This end is graduated to indicate inches per foot, and you will notice that I have set it at ½ inch per foot, which is proper for a Brown & Sharpe taper. You cannot depend on these graduations, however, for more than an approximate setting. The shank should be ground enough so that it is nearly cleaned up and then tested with the gage, first wiping it clean and dry and putting a light chalk mark lengthwise of the shank; then when you try it into the gage and twist it around, if the chalk mark is rubbed off evenly and it seems to stick in the gage, it fits all right. If one end of the chalk line is rubbed off and the other is not it shows that the table should be adjusted to make the end on which the chalk was rubbed off a little smaller. You will note that the gage is marked "Tang to project ⅜ inch"; and when you have ground the shank small enough to let the end project ⅜ inch you have it the right size. You should watch when you are first starting to grind a mill to see if it runs out badly from being sprung in hardening, which frequently happens. When the work is not too badly sprung you can scrape the center in the shank over enough to get the mill to clean up all right, but if it is sprung too much for this, bring the part to me and I will have it hardened over again. When you have the shanks all ground you can grind the teeth on that little universal cutter grinder." And with that he left Jim to himself. He got along all right until he had the first one down nearly to size. As the wheel had not been dressed off, the work was rather rough. Jim noticed it but did not know what was the matter, though he could readily see that the finish was not as good as it was on lots of work he had seen. John Cary was working on a surface grinder nearby, and he asked him if there was not some way to make that machine grind smoother.



Figs. 1 to 4. Testing the Teeth of End Mills for Clearance

"Why! I should say that if the wheel were trued off it would do a better job," said John.

"How do you true it off?" asked Jim.

"Get a diamond from the tool-room and fasten it in the holder; then with the wheel running move it slowly past the diamond—you get the diamond and I'll show you how."

When Jim came back with the diamond John went over to the machine and looked the work over; then as he dressed the wheel off, he said, "I'll tell you how I manage when I have a lot of pieces that are alike, as you have here: I true the wheel off once when I begin the job; then I rough grind all of my work down nearly to size, leaving about 0.0015 stock for finishing. After that I true the wheel off again and finish one piece and note the reading on the dial of the feed handle. By bringing the handle to the same place for each shank you can get them all the same size without taking each one out to try it two or three times. You can also do this when you are roughing them out, only the wheel will wear off more in taking off so much stock and you will have to feed it in a little further each time. When you are roughing off work, it is almost impossible to do a job in reasonable time and have the wheel stay true, and you would have to dress the wheel on each piece to do a good job; but in roughing out, the wheel will stand some crowding and still be true enough to get the stock off rapidly. If you rough all the pieces first, when you come to finish them they will be round and clean, and as you have only one or two thousandths to take off each piece the wheel will easily stay in good shape to finish a dozen shanks. Use plenty of water at all times as it keeps the work cool and helps to keep the wheel clean."

"Thank you," said Jim, "I'll do it that way."

Jim got the shanks ground in reasonably good time, and in the meantime he watched a man that was sharpening some end mills in a machine like the one that Mr. Corbin had told him to use for that purpose, and he saw him take a mill out of the machine after he had ground two or three teeth and hold the mill up to the light with a scale across the teeth. Going over to him he asked him why he did that.

"I do that to see if I have the right clearance," said he.

Jim picked up a mill that he had not ground yet and held it up to the light, using his scale as a straightedge, as he had seen him do. "Oh," said Jim, "you grind the teeth at an angle with the face that will show clearance when the scale rests on the tooth following it." (See Fig. 1.)

"No! I don't! That gives too much clearance. Here try this one," he said, handing him one that he had just ground.

Jim held the scale on that and saw that it looked altogether different; in fact, it did not look to him as if it had any clearance at all.

"Why, on this one the scale does not even touch the following tooth. Surely, that is not clearance enough."

"Yes it is," said he. "As long as the distance from the cutting edge of the following tooth (*A*, Fig. 2) to the scale is less than the distance from the scale to the tooth in front (*B*, Fig. 2), you have clearance."

"But why was this mill ground like this?" said Jim, pointing to the mill he had first picked up.

"Some fellows have a wrong idea as to the amount of clearance needed, and that mill was not inspected after it was ground. It has altogether too much clearance; there is no support to the cutting edge, and the result is that it will get dull before it will do half the work it should. Let me take that flexible scale of yours and I will show you. There!" said he, now you can see the actual clearance it has when at work." (See Fig. 3.)

"Yes," said Jim, "that does look like too much."

"Now try the one here that I have just ground. See the difference? And there is plenty of clearance, too." (See Fig. 4.)

"I see that there is now, but at first I was inclined to think that you were joking with me. I have been sent for left-hand monkey wrenches, and to the blacksmith to get file teeth drawn out, and on other fools' errands, until now when I see or hear something that does not look just right at first, I am like the man from Missouri—I 'have to be shown.' Well, I have got these shanks about ground, and the next thing is to grind the teeth. I suppose that I will have to set that ma-

* Previous installments of this series of articles appeared in the numbers for August and December, 1909.

chine up as you have this one."

"No, I'll be through here in a few minutes and you can have this one. That one is all set up for grinding the teeth on the ends and I will finish my job in that. It will save us both work."

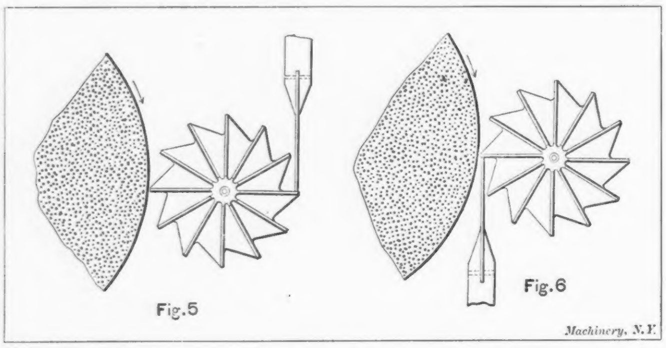
Jim wiped off the grinder and returned the gage and diamond to the tool-room and then started in to grind the teeth. As the machine was all set up he had no trouble at first, and he remarked to his friend on the other machine that "it was not such a very difficult job to grind cutters."

"No, the most important part is to get the clearance right and keep them straight. If they are not straight it is difficult to do accurate work with them."

"What is the best way to tell if they are straight?"

"Oh, just measure each end with your micrometer and keep them within a half a thousandth or so of the same size." Then as his job was finished he gathered up his work and tools and went away.

Jim got a two-inch micrometer and went over the mills he had ground and found that they were pretty straight. He



Figs. 5 and 6. Incorrect and Correct Methods of setting Tooth-rest

had only two more to grind the side teeth on, and one of them was the one that he had made the mistake on when he was milling it up. He put it in and started to grind it when he noticed that on one of the teeth the wheel did not cut at all, while it took a good cut off the others. He saw at once that something was wrong, and as John was still working on the surface grinder he took the mill to him and asked him what was the trouble. John looked at the mill and said, "Your machine is not properly set up."

"Why, it is just as that man who left a few minutes ago was using it, and he seemed to think it was all right."

"Well, I suppose it is all right for mills on which the teeth are evenly spaced, still I would rather have it set differently if I were using it, and not take any chances."

"What is wrong about it?"

"The finger which you use to index with should bear against the same tooth that you are grinding (See Fig. 6) and not on the opposite side, as it is now. (See Fig. 5.) With the finger, or stop, resting against the tooth you are grinding, all the teeth stand in the same position in relation to the wheel while they are being ground; while if it rests against any other tooth any inaccuracy in the spacing of the teeth makes an error in grinding. Of course, ordinarily the teeth of mills are properly indexed and it would make little difference, but you will occasionally find a case like the mill you have here, and also cases where the face of the teeth have been ground free hand, especially saws, etc., where it becomes necessary to grind new teeth because the old ones were worn too short to work good, and in such cases it is impossible to grind the mills or saws so that they will work good unless the tooth that is being ground is the one that rests on the index finger."

"I wonder why that man did not say something about that? He seemed to be a pretty good fellow."

"Probably he did not think that any of your mills had irregular spacing; or it may be that he never took notice of that feature. No one man knows all about this business, you know. We all have our failings and are never too old to learn something new to us and old to the other fellow. I have seen grinding machines put on the market by some of our most reputable machine builders, so designed that it was impossible to get the index finger underneath a cutter in the proper position. Still it is easy to demonstrate that it must be there to do good work."

Jim changed the machine by putting the arm that holds the finger into the binding socket from the bottom, then on re-grinding the mill he found that it acted differently. But on measuring the mill up with his micrometer he found that the tooth that was off in the indexing was apparently small, and he asked John the reason for that.

"That is all right," said John. "It is small because the two teeth you are measuring are not exactly opposite each other. If you had means of measuring the radius of each tooth, you would very likely find them all the same. If you doubt it, put the mill on the lathe centers, clamp an indicator in the tool-post and revolve the mill slowly by hand with the indicator just registering zero as the cutting edge of the tooth passes it and you will probably find that all of the teeth are of the same height."

"I think I understand what you mean," said Jim, and he went back to his machine and finished up his other mill, after which he called John over and asked him if the other machine was properly set up to grind the teeth on the ends. John looked it over and said, "I think it is, but we can tell better by putting a mill in and grinding it. There are two things to look after in grinding the teeth on the end of a mill. One is to get the proper clearance and the other is to be sure that the center of the mill is not higher than the outside. If the center is high it will not leave an even surface when at work; that is, if you were milling a plain surface on which it was necessary to take several cuts side by side you would find that the center of each cut would be low, leaving furrows on your work; while if the center was low this would not occur, so you see it would be better to have the center of a mill a little low, if anything."

"How do you tell when it is low?"

"By holding a straightedge across the two teeth that are opposite each other and noting that there is light underneath

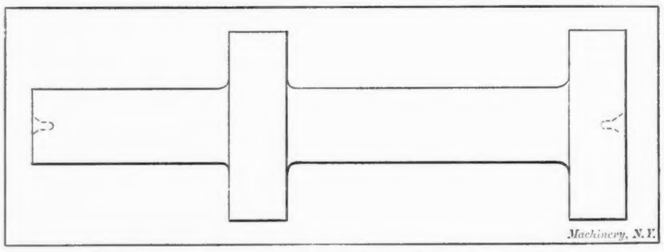


Fig. 7. Test Piece used to set Grinder Table Straight, prior to Internal Grinding

the straightedge in the center of the mill. Or, in case of an odd number of teeth, by rubbing the end of the mill on a plain surface on which you have rubbed a thin coat of prussian blue, then if the mill is properly ground the blue should show on the outer edges of the teeth and very little, if any, in the center. You very seldom find mills with an odd number of teeth, however, as it is difficult to measure the diameter of such mills, and unless it is necessary for some special purpose, they are not made. This machine seems to be all right, but a coarser wheel would be better, as this one is so fine that you are liable to burn the teeth if you are not careful."

"What do you mean by burning the teeth?"

"Why, drawing the temper from them. I don't suppose that it would be possible to burn steel in the way that it could be burned, or overheated, in a blacksmith's fire, by grinding. It is just an expression that machinists and toolmakers have coined for their own use and means heating the steel by grinding until its temper has been drawn. You will be able to notice it by the outer edge of the teeth turning blue."

"It seems queer to me," said Jim, "that this high-speed steel, which will remove chips of a blue color, could be injured by drawing the temper to a blue color."

"Well, to tell the truth, it does to me also, and I am unable to explain why it is so, but I do know that a great many brands of steel will not stand it. There are some brands of high-speed steel that the makers claim cannot be injured by heating on a grindstone or emery wheel, but I never saw any

that was improved by it, and I would much rather be on the safe side because steel on which the temper would not be affected will generally crack and check until the cutting edge would crumble away under a cut."

"But why is a coarse wheel less liable to heat a tool or cutter than a fine one?"

"A wheel for grinding metals is built up of numerous particles of abrasive material held together by a bond, or cement, and in a way could be likened to a milling cutter, as it actually cuts chips off, though, of course, they are very small and cannot be recognized as chips except under a strong magnifying glass. Now if you were to use a milling cutter with very fine teeth and force it to take all the cut it could, each tooth would cut until the space in front of it was full of metal when it could cut no more; then if it were not yet free to discharge this metal, or had not passed over its cut, it would have to carry the metal along rubbing hard against the work until it could get rid of it. By this time perhaps the metal is jammed in so hard that it sticks fast, and when the tooth comes around again it is already full and can only rub past the work, causing much more heat than it would if it could cut. On the other hand, take a coarse cutter and there is plenty of room for the chips, and each tooth can cut all the time that it is in contact with the work without crowding the space full of chips. It is the same way with emery, or abrasive, wheels; the coarse ones are adapted to remove metal fast without generating much heat, while the fine ones are more for putting a smooth finish on work, but they must not be crowded or the teeth will become full and the wheel will rub along instead of cutting freely."

Jim finished all the grinding on the mills and took them to Mr. Corbin, who looked them over and pronounced it a good job. "Now," said Mr. Corbin, "your surfacing mills are ready to be ground, and that will finish them. Take them over to the same machine that you used to grind the shanks on the end mills. You will find a chuck over there that will fit on the spindle of the head-stock; put that on instead of the driver, unlock the spindle so that it can turn, and shift the belt onto the pulley that is fixed to the spindle; then you can chuck the mills and grind the inside the same as you would bore them out in a lathe. There is an internal grinding attachment for the machine and you can get some one of the men that is working over there to show you how it is set up, as I have not the time now. I'll be over after a while and see how you are getting on."

Jim carried his work to the machine, put on the chuck and chucked one of the mills; then he asked John about the internal grinding attachment. John pointed it out to him, and told him that to put it on the machine he would have to remove the wheel from the main spindle and mount a pulley, which he showed him, in its stead; then turn the spindle head around and mount the attachment on the support provided for it and connect the spindle of the attachment to the main spindle by a belt. "Did you set the machine straight before you chucked your mill?" asked John

"No," said Jim.

"Well, you will find it a rather difficult job to get it straight unless you do it first."

"I don't know how to get it straight other than to set the graduations at zero."

"Here in this cupboard is a piece of steel that we use for that purpose. (See Fig. 7.) Take your mill out of the chuck and put this in instead, catching it by the small straight end; set it as true as you can and then take a cut off the two disks. When you have the table set so that your cut leaves both disks the same size, using a micrometer to measure with, the machine will be set to grind a straight hole. If you chuck the piece pretty true, you can get it nearly straight by noticing on which disk the wheel throws off the most sparks, and changing the table accordingly. Leave the big wheel on the spindle until you get the table set straight, as it will cut faster than the small one. When you are ready to put on the attachment, let me know and I will help you to get things right."

Jim got the machine straight in a short time and then removed the wheel and made the other changes that John had mentioned; then he called him over and asked him if he had things right.

"Yes, I think so," said John, "but you will have to get a new wheel, as that one is about worn out. Tell the stock-keeper that you want a wheel for internal work, if Mr. Corbin does not specify it on the order. You will probably have to turn it down with a diamond until it is small enough to go in the hole, as the wheels to fit this fixture do not come less than $1\frac{1}{2}$ inch in diameter."

"How would you chuck the mills?" asked Jim; "true with the outside or inside?"

"True with the outside first; then watch when you start grinding and if the hole runs out so that there is danger of it not cleaning up, chuck it so that it will, leaving the outside as true as you can."

"But how can you tell that it is going to clean up before it is finished?"

"Well, until you get enough ground out so that you can measure the diameter of the hole, or until the cut covers more than half of the circumference in some one place, it is simply a matter of judgment; but after that it is a simple matter that is familiar to most lathe hands. Measure the diameter of the hole as the cut leaves it and subtract this size from the finished diameter; the difference is the amount of stock on both sides of the hole. Divide the difference by two and add the result to the size of the hole as it measures; set a pair of common inside calipers to this size, using an outside micrometer to set them to; then if there is no place in the hole that the inside calipers will not touch, the hole will clean up. For instance, suppose you grind out one of the holes so that you can measure the diameter of your cut, and then set a pair of inside calipers so that you can just feel a touch with both legs resting against a ground surface; then set an outside micrometer to the inside caliper so that you can get the same touch as you did in the hole, read the micrometer and find that you have ground the hole to, say, 1.242 inch diameter. The hole is to be 1.250 inch when finished; then $1.250 - 1.242 = 0.008$ inch stock still to be removed. $0.008 \div 2 = 0.004$; $1.242 + 0.004 = 1.246$. Set your outside micrometer to this size and set your inside calipers so that you get a light touch on the micrometer; then with the inside calipers measure the hole, and if you find no spot where the calipers are free, the hole will finish all right. You want to be careful though that the wheel is cutting full size when you take the cut that you measure from, for if it should spring away from its cut for a thousandth or so your measurements would be off. It is best to have apparently a couple of thousandths to come off the lowest spot; then you are sure. You will find that internal grinding is different from outside work, especially in small holes. It is necessarily a much slower job and cannot be crowded if you expect to do good work."

"Do you use water?" asked Jim.

"No. On outside work water washes the grindings away and helps to keep the wheel clean while the reverse is the case with inside work. However, it is a good idea to cool the work with water before trying in a plug or hardened and ground sizer; for if the work was warm and you inserted a cold sizer that would just go in, unless you were pretty quick in pulling it out again, it would be very likely to stick, as the hole would close in and the sizer expand, on coming in contact with each other."

Jim got on pretty well with his work and had a couple of the holes ground when Mr. Corbin came to see how he was getting on. "You seem to be going at it all right," said Mr. Corbin.

"The credit for that is due to Mr. Cary, there, who showed me how to go about it. Where will I grind the ends?" asked Jim.

"On this same machine. There is an expanding arbor that fits the spindle in the place of the center; put that in and loosen the nuts that clamp the headstock and swing it around so that the graduations read 90 degrees, and clamp it fast again. Then slip one of your mills on the arbor and secure it by tightening the screw in the end of the arbor; take off the internal attachment and put the big wheel back on the spindle, then you can back the wheel away until it will clear the mill, set the stops so that one reverses the travel of the

wheel at the center and the other at the outside. Let your cut come on the side of the mill that is traveling upward. The mills should be ground so that they are square across the ends, or if anything a very little concave. When you get the ends ground you can grind the teeth on the cutter grinder that you used to grind the end mills on." With that Mr. Corbin left Jim to himself again.

Jim got the holes all ground out and the machine set up to grind the ends. As he started in to grind, however, he found that the head was not set quite right to get the ends square, and he made several efforts at re-setting it without much better results. John noticed him and coming up said, "Leave the head clamped as it is and make any other adjustment you wish by changing the whole table the same as you would if you were grinding a taper. The screw adjustment on the table is much more sensitive and it is no trouble to move it as little as you like. You want to be sure and keep your wheel clean at all times so that it cuts and does not glaze the work by rubbing. Glazing seems to set up a strain in the metal; sometimes enough to burst the mill lengthwise. I broke two mills myself in this manner before I found out the cause; the tool hardener got the blame for it, and at the time I thought he was to blame, but I have learned since, from experience and observation, that it was my fault. I have seen several mills that broke during the grinding operation or shortly after, and all that I ever saw had a smooth glazed surface and under close examination would show numerous small checks all over the glazed part. I never like to see a smooth glassy surface on hardened and ground work unless it is obtained by lapping, and if such surfaces are afterward lapped they will generally show up more irregular than one obtained with a sharp wheel. In thin work such as saws, templets, etc., if the wheel is allowed to glaze, or even approach that condition, the work is sure to buckle."

"Is it much of a job to grind the spiral teeth on these mills?" asked Jim.

"No," said John, "it is an easy matter. The only difference in grinding straight and spiral teeth is that for spiral teeth the index finger is secured in a fixed position in front of the wheel; then when the mill is pushed by the wheel, the face of the tooth resting on the finger, which does not move, causes the mill to turn just the same as it did when the teeth were cut. The top of the finger should be rounded slightly so that the face of the tooth bears on the center of it. The wheel should be trued off so that that there is only a narrow cutting surface, and the finger should be wide enough to allow the tooth to rest on it before the wheel begins to cut, which should be when the end of the mill approaching the wheel reaches the highest portion of the rounded end of the finger.

"How do you hold the cutter?"

"You can either put in on a solid arbor between centers, or there is a hollow arbor for that machine with stepped collars to fit the standard sized holes in cutters; this arbor slides on a round bar that may be mounted in a fixed position in front of the wheel. This latter method is the best as there is no possibility of getting one end of the mill you are grinding smaller than the other, in fact, nothing but straight mills can be ground in this way. Well; I have got my job over here finished and I'll have to pick up and leave. If you run into anything you can't master, let me know and I'll do my best to help you out."

"Thanks," said Jim. "I think I ought to be able to finish up this job without bothering anyone any more."

* * *

As photographs are becoming more and more commonly used as evidence in legal cases, the *Engineering Record* calls attention to the necessity of having photographs thoroughly identified. Engineers and contractors who make a practice of taking photographs as matters of record would do well to have some independent representative present at the time each photograph is taken, so that he could go on the witness stand and testify that the views were taken in his presence and correctly represent the conditions on the dates when they were taken. Unless some such plan is followed the court may refuse to accept photographs as evidence on the ground that they are not properly authenticated.

TOOLS FOR DRAWING SEAMLESS AUTOMOBILE LAMP HOODS

WILLIAM A. PAINTER*

The drawing dies and punches for drawing a rectangular hood for automobile lamps, in one piece, are illustrated herewith. The advantage of a one-piece hood over the regulation built-up and riveted one is the convenience in cleaning, there being no seams or rivet heads to catch the rouge, cleaning compound or polishing cloth; in addition, the hood has more pleasing lines and greater accuracy can be obtained.

A rectangular shell or drawing is more difficult to produce than a circular one, especially where the corners or angles

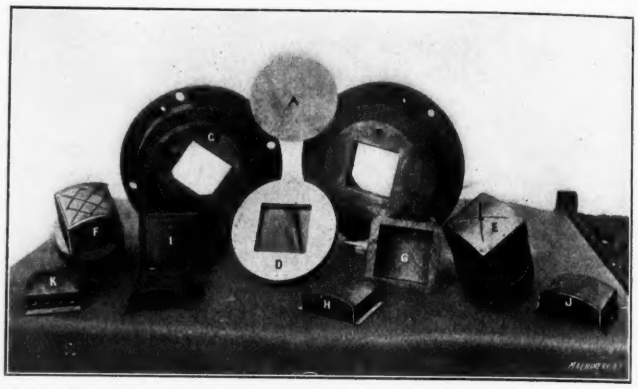


Fig. 1. Punches and Dies for Rectangular Lamp-hoods and the Stock Before and After the Drawing Operations

have to be sharp, as the rapid flow of metal to the corners, when reducing from the flat, being out of proportion to the rest of the area, has a tendency to clog and tear the metal. This hood is made of brass, and measures 1 7/8 inch deep and 4¼ inches by 4½ inches across the sides; it is made from a round blank *A* (Fig. 1), the quantity not warranting a special blanking die attached to the drawing die.

The shell is drawn in two operations. Two dies of the same size are used, except that the drawing edges of the first die are rounded, while the second one is sharp. The cast iron shoes or holders are duplicates, and are made for a double-action press. The first drawing operation is made in die *D*, which is set in the holder in place of die *C*, which is the finishing die. The sleeve *B* is used in both operations. The

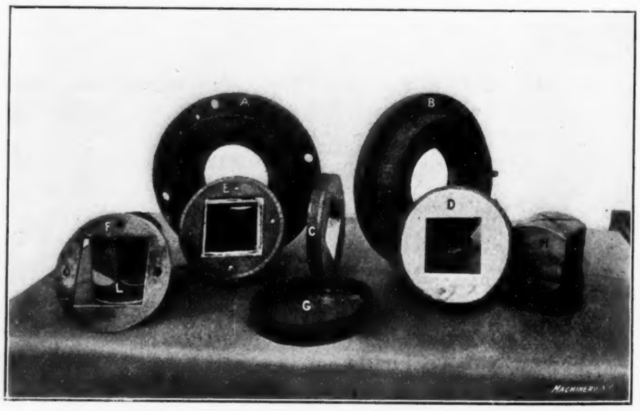


Fig. 2. Protective Shields used for Local Hardening and Dies with Shields in Place

blank *A* is held in place on die *D* by spring gage-pins, different holes being used for different depths of hoods. After the first operation, the flange on the shell is nearly rectangular in form, as shown at *G*. The flow of metal to the corners is also shown, proving that a circular blank is the correct shape, and not a rectangular one, as this shape would not draw at all.

The rounded punch *F* for the first operation and also the one shown at *E* for the second operation are both vented by holes and cross channels; the object of this is to prevent the punch from drawing the finished shell upward by suction on the return stroke of the press. The holes alone would not be of any advantage, as the sheet metal would cling to them and stop the passage of air, but with the channels this is overcome.

The first operation draws the shell to within 3/16 inch of

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full depth. The shells are then annealed, and the sharp draw-punch *E* and the die *C* are put in the press. The shell enters the die and rests on its flange, and is held by a sleeve while the punch enters. This operation sharpens the edges only, as the drawing of the metal has been accomplished in the first drawing die. The partly completed hood is shown at *H*, while different views of the finished hood are shown at *J* and *K*.

The dies and the sleeve are held in place by six half-inch square-head screws. The cast iron holders are bored straight to fit the dies, which are beveled five degrees in the center of the rim, leaving about 5/16 inch of straight surface at the top and bottom as shown at *C*, Fig. 2. This straight surface is an easy fit in holders *A* and *B* so that the dies can be revolved when the screws are loosened; the object of this is to permit first tightening the punch on the thread of the plunger when setting up tools, without regard to the relative positions of the die and sleeve. When a shell is put in the die and the bed is set to match the screws in the bolster, if the die is free it can be revolved until it matches the punch; the punch is then entered into it and all screws are tightened. This operation is repeated on the sleeve or pad, and it eliminates packing the punch with washers to make it line with the die, as well as the risk of the punch jarring loose and breaking the die or sleeve.

These dies were hardened by my local hardening process, as the shape and angles of the disks would make it a hazardous operation to harden them in the regular way. [For a description of this hardening process see Mr. Painter's article on Local Hardening and Tempering, August, 1908.—Editor.] The dies are 9½ inches in diameter, 1¼ inch thick, and only 1½ inch from the corners of the rectangular hole to the outside, so that the strain in hardening would be at these sharp corners.

The face of the die with one of the steel covers used in the local hardening process in place is shown at *D*. The back of another die when covered to within ½ inch of the square hole is shown at *E*. There are four ½-inch holes in this cover to equalize the cooling. The covers for die *C* are shown at *F* and *G*. These are the same as those shown in place at *D* and *E*. The thickness of the stock from which these covers are made is 0.025 inch. The band *G* is slit with shears and held together with rivets.

These dies were heated in a gas oven and then dipped in clear water. They did not shrink or warp, and have been used for drawing thousands of hoods. The punches *H* and *L* have machine steel bodies and tool steel working ends. The ends are hardened on the outside only, sheet steel being applied to the back of them when hardening. All these covers were put on before heating the parts and were dipped with them. The temper was drawn to a light straw color after the covers were removed.

* * *

At a recent exhibit of gas appliances in New York, certain power-driven machinery was shown, having exposed bevel and sprocket wheels in operation. To prevent accidents to visitors, they were protected with wooden shields, sufficiently to keep the inquisitive sightseer out of harm's way. In regular manufacturing use, however, we infer that these potential instruments of accident are absolutely unguarded, so far as the maker has provided. The extra cost of providing efficient gear guards would perhaps be two or three dollars at the most. What is the use of saving a few cents where the saving may mean the loss of a finger, hand or arm? Even if the humanitarian aspect is ignored, it is poor business policy of the user to let such man-traps exist, and he has a right to expect the manufacturer to supply his machines guarded in all respects where possible. Damage suits are ugly affairs; the defendant is beaten even if he wins because the ill-will and hatred engendered will cost him much in the end.

* * *

The value of the imports of machine tools to Hungary, according to recently published statistics, amounted in 1907 to about $900,000. Machines to a value of about $500,000 were imported from Austria, $325,000 from Germany, and only $58,000 from the United States. Recent developments show that Hungary offers a fair field for the machine tool trade.

YOUNG BRAINS AND OLD

A. S. ATKINSON*

It goes without saying that the young man has a better chance to-day than the old chap who has passed fifty, and when you get past the latter age, woe be unto you if you lose your job. It doesn't seem to matter very much that our grandfathers took more stock in age than in youth and looked upon the man under thirty as of little real account in the business and manufacturing world. Age meant maturity of judgment, and one couldn't be sure of himself much under fifty. So they put out their sign of "Slow and Sure."

Now we have reversed conditions, and every shop and business concern is picking up the young man and dropping the old. Of course some old codgers can't be shelved. They simply bob up smilingly and get there just the same. Nevertheless, the old sign has been reversed, and we read the warning, "Young men wanted; no old men need apply."

Well, of course, that's all right if everybody believes that a man of fifty has lost his usefulness and is chiefly good for holding down cheap jobs that an office boy fresh from school could do as well; but sometimes the "Oslerizing" process may be carried a bit too far. I suppose I am particularly interested in it because of the story about "Old Si Smith," which I related in a recent number of MACHINERY, and of another little experience of "Pop" Lester's, who took his medicine like a man and then got cured of the "old age delusion."

"Pop" was superintendent of the big machine shop whose sooty black smoke can be seen any day clouding the atmosphere up on the Hudson, just far enough beyond the city line to escape the Health Board's edict that nobody shall burn soft coal in the metropolis. This shop is one of the oldest in the country, and it had the reputation of doing some of the finest work on this side of the Atlantic. The old man who built it up had made Pop superintendent way back in the eighties, and under his wise management the profits had been large enough to please anybody except a modern millionaire's son anxious to get the record for fast spending.

Anyhow, when the old man died and the young chap inherited the fortune and the big machine shops, there was bound to be some sort of a change. The youngster came down to look the shops over, and brought an expert with him. They went through the shops, under the guidance of Pop Lester, the superintendent, and the way they commented on the machinery and equipment was enough to drive a good machinist crazy. "Antiquated," "Out of date," "Fit only for the scrap-heap." These were a few of the epithets they used, and Pop winced and bit his lips. He tried to explain that some of the machinery was almost as good as new, and that all of it was doing first-class work.

They didn't listen much to these apologies for the machines; they had a reason for their inspection. It didn't come out right away, but after a while it leaked. The young heir wanted to increase his profits, so he could spend a few more dollars on Delmonico dinners and chorus girls, and the machine expert was looking for a good fat job as superintendent and incidentally for some liberal commissions on machinery. They both had their way in time. Pop was kindly and thoughtfully relieved of his position, the young owner explaining plausibly that he wanted the shops run on modern methods, and he thought a young superintendent could do the trick better than an old man. His father had been all right in his day and time, but things had changed a good deal since he was a young man. The shops were in a bad way, and were not making half what they should. He had figures and facts to show it. Here they were, if Pop wished to examine them.

The old superintendent was too surprised and dumbfounded to protest or even to examine the paper shoved toward him. You see he had been the head of the shops so long that he had got into the habit of considering it a life job. It would have been, too, had the old man lived.

Pop wasn't exactly turned loose to shift for himself. That youngster condescendingly said that the deposed superintendent could take a position in the drafting-room, where he

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could make himself useful at twenty per week! Think of it!—when his salary had been running into figures that would pay for a first-class automobile once a year!

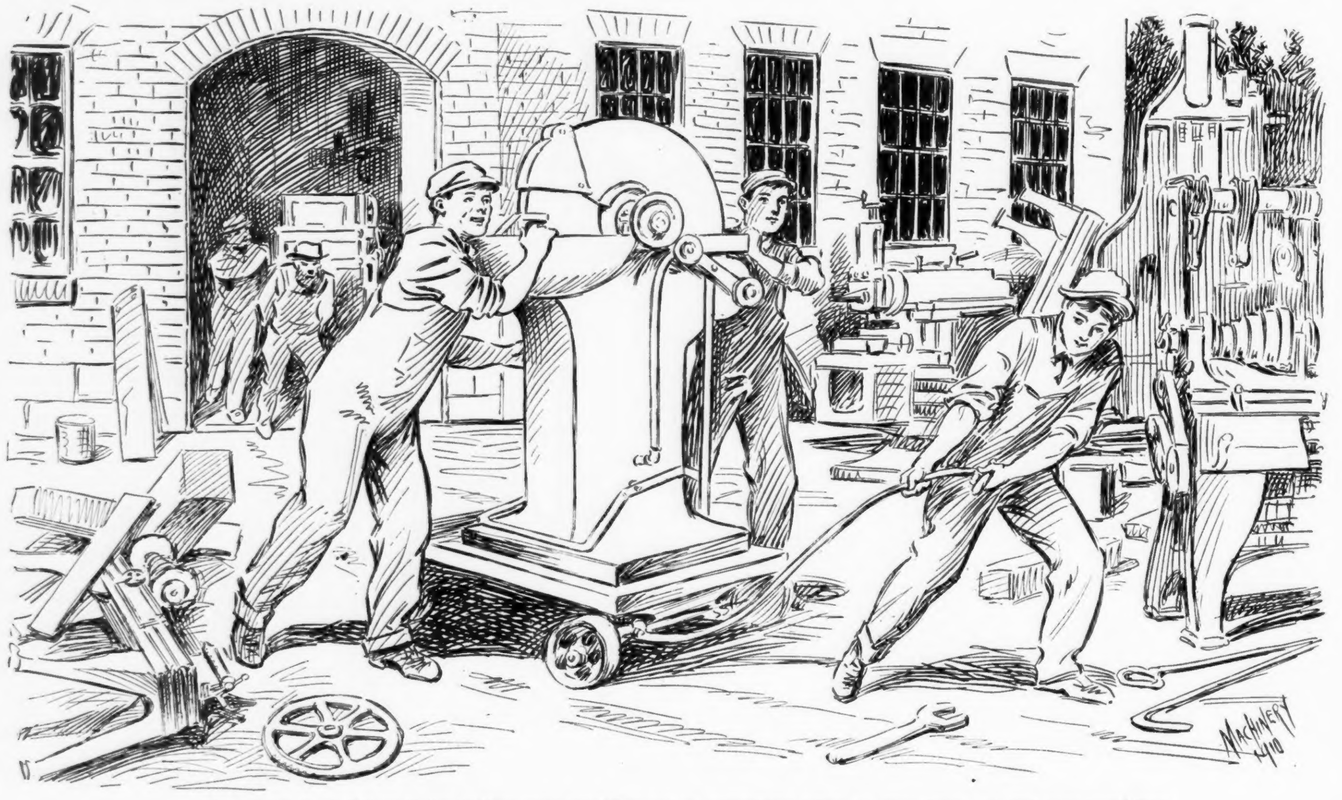
We felt sorry for the old man, every one of us, but we had too much to think about in holding down our own jobs without openly rebelling for the sake of another. Pop had been kind and considerate to every one of the boys, and we didn't forget it now. We went round in a delegation and asked him what we could do for him. Go on strike? "Good Lord, boys, no!" he said. "We never had a strike in these shops—not since I've been here—and I'm not going to be the cause of one. Go back to your work and hold your own jobs. I'm mighty thankful, however, for your expression of confidence in me—mighty thankful."

The new superintendent was about as boyish-looking as the young owner of the shops, but a little bit shrewder and more experienced. He knew more about machinery than his employer, and possibly more about men and business. At any rate it had all been framed up before he took hold, and the first thing they did was to rip out the old machines. Say, it was a waste of good material, and it gave you a real heart-ache to see the machines smashed up and carted away. Why, some of them weren't more than a year or two old, and some had done good service for five years and were good for five more. Some of Pop's old pet machines, a big jig-saw and a boring mill he'd had for ten years, were a little out of date and had been patched up some, but they hadn't lost five days for repairs or breakdown in all that time.

Pop had been a little economical in a way; he always hated to turn down an old machine for a new one until he was pretty well satisfied its days of usefulness were gone. I suppose he looked at 'em most as he looked at himself. A machine must wear out in time, and if you keep it long enough it will get out of date. But it isn't good policy to hurry it along to the scrap-heap too fast. Pop must have felt as if the bottom was tumbling out of everything when he saw those old and new machines ripped out of the shops and new ones put in. But he had nothing to say and the machines were sold for scrap and for second-hand machines, just as bidders chose. The new machines came in and were put up by experts. They looked all right, and were all right, and they had many new improvements. Some of 'em could do double the work, and I guess it was only a question of time before the young owner would find his profits increased. But we lost a lot of time making the change. Some of the orders ahead had to be cancelled, and others we lost through delay, so the contracting parties threatened to sue the young owner. There was a lot of legal quarreling, and a good deal of trouble all around. The young superintendent, I guess, hadn't figured on the loss of time the big change would make, and neither had the owner.

Well, things finally got started. We had a few new orders, and we started on them. But all that machinery was new to many of the men, and they had to go slow. The young superintendent told the foreman of the shops that he had to make up for lost time, and he tried to push us, but you can't be pushed when you're riding a new horse, and we had a lot of breakdowns and ruined much work. The more the foreman drove us, and the more the superintendent fumed and threatened, the worse we seemed to get, and the new machines showed they were nervous, too, or something like it.

Then pretty soon another trouble followed. Some of the work the shops turned out wasn't satisfactory and didn't come up to specifications, and the buyers refused to pay or threatened to sue the shops for swindling them. Now the old man had earned the reputation for superior work in the past, and his name stood for more than most people's bond. When an article came out of his shops and bore the name of the firm, it was accepted without question everywhere. This reputation meant a lot more to the shops than the young owner realized. At first he told the kickers to go to some hot place, and the others he defied in court and got all he wanted of such proceedings. I suppose he had to have the experience to cool him down and make him understand that even a millionaire isn't the only toad in the big business puddle.



"Pop must have felt as if the bottom was tumbling out of everything when he saw those old and new machines ripped out of the shops and new ones put in"

Things went from bad to worse in this way, and by the time we got used to the new machines the shops had a dozen lawsuits on hand and a lot of rejected junk that buyers had shipped back to us. But worse than all this, we'd tarnished the reputation of the old man's shops for first-class work. I guess instead of increasing his income, the new superintendent had cut a pretty big hole in his employer's bank account.

We heard something about this from their talk around the shops, and they put their heads together to find some remedy. The first thing we knew about it was they'd decided to cut wages. That was something that had occurred only twice in the history of the works. Once when hard times hit the business world, the old owner had appealed to us, and said he'd have to cut wages for a time to prevent losses, but he'd restore them within six months or a year. This same thing

happened ten years later, and each time we met the cut with a smile and assured the old man it was all right. He'd stood by us, and we'd stand by him. But now nothing was said about restoring the wages later. Indeed, when our committee spoke about it, they were pretty nearly kicked out of the office, and told to mind their business or they'd be "chucked" out body and soul. Pleasant, wasn't it? Just the sort of "dope" to make self-respecting workmen love their employer. We did, of course, and stood ready to grovel on the ground before him. We talked it over, and decided that for the present no strike would be called. We felt proud of the reputation of the shops, and didn't want to disgrace them. We stood it quietly for six months, and then we asked again if wages would be restored to their old standard pretty soon. We got our reply all right, and it was right in the face. It came in the form of another cut, and a pretty deep one. We couldn't stand for that, and we struck—every mother's son of us. We walked out and let the machines stand idle, and then the most distressed man around the diggings at that time was Pop Lester. He was genuinely sorry and worked up. He went around among us and begged us to refrain from any violence. He tried to excuse and apologize for the young owner and the new superintendent. But there wasn't much to say in their behalf, and Pop had some pretty weak arguments to present.

A big strike in a machine shop isn't an easy proposition for any employer to face, and that kid and his kid superintendent found before they were through they had to do some hustling. You can't pick up five hundred skilled workmen every day in the year, especially when the wages offered were small. So the strike drifted on for several months, and then to six months. The plant was losing orders right along, and it was costing the owner a pile. I guess he had to cut out some of his expensive dinners and chorus girls.

It was the most peaceful strike I ever saw. Pop was around night and day, and we listened to his advice and kept from doing any harm. They managed to get a dozen or two men in the shops, but they ruined more work and machines than anything else. Then one day Pop Lester came around with a more serious look on his face than ever, and when he got enough of us together, he said: "Boys, I want you to go back to work to-morrow—for my sake."

"Too much to ask, Pop," somebody yells out. Then another says: "If you'll be superintendent of the shops, we'll go back at the old wages."

The old man smiled and answered: "That's just what I came to tell you. I've got back my old job, and I want every man here to get his, too."

There were plenty of wild cheers then, and some of them were so noisy that we had to wait a long time for the old superintendent to finish. "You will have to go back at the lower wages," he continued, "for the plant has lost lots of money, but as soon as we get some of it back, we'll restore wages."

Did we go back? You bet! The next morning every man was in his place, and things began to hum. Pop was kept as superintendent after that until he died; and as for that youngster, he learned his lesson, and now before making a big change he always consults with his old reliable guards.

* * *

The use of lava for gas burner tips dates from 1854 when J. von Schwarz discovered its advantages for the purpose. The lava is found in Bavaria at the southeastern point of the Fichtel Mountains, near Bayreuth. It has been used for hundreds of years for musket balls, marbles, fireproof utensils, carved ornaments, etc., being readily turned, sawed and polished. It does not disintegrate with long-continued and repeated heatings, and its smooth non-porous surface prevents carbonization and deposits from the gas.

* * *

The value of the yearly import of machine tools to Spain amounts to about $600,000, and Germany supplies more than one-third of the machine tools imported. Apparently Spain offers an opportunity for the increase of the foreign trade of the United States in machine tools.

JIGS IN A REPAIR SHOP*

A. H. LAVERS†

That jigs are an indispensable factor in economical quantity manufacturing is undisputed. As a necessary element in repair machine shops that are a part of any manufacturing establishment, where the shop is used merely in repairing and building additional equipment, the use of jigs has apparently been neglected to a greater or less extent. This applies particularly to plants in which repairs must be interchangeable and effected at short notice.

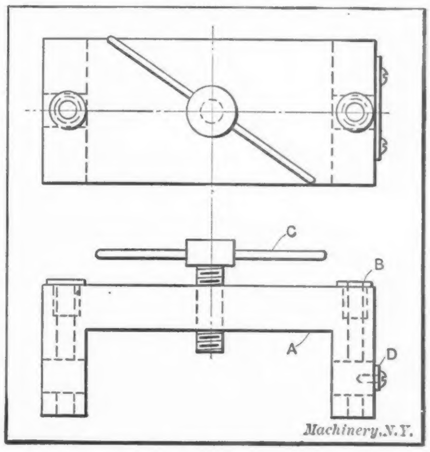


Fig. 1. Simple Form of Jig for Drilling Two Holes in Shaft Ends

In the case of pipe flanges and fittings, or standard parts, it pays to make up fairly expensive jigs, as a standard once established can rarely be altered without causing confusion. The cost of jigs for parts of machinery constantly undergoing changes and improvements, is usually the most important feature, although the time element in duplicating parts must not be lost sight of. Another point that undoubtedly has a bearing on the question is to make the jigs as simple and fool-proof as possible, thereby permitting the employment of unskilled labor in drilling operations and minor lathe jobs.

As a usual thing, repair shops of this character are supplied with drawings of a machine and an order to build one, which, if satisfactory, would necessitate the building of several more. At once the question presents itself: If the machine is satisfactory, what parts will wear out, call for replacement and the use of jigs in repair? This must be decided and then the simplest possible design of a satisfactory jig should be made.

It is good practice to leave the judgment of matters of this kind to some one man who is familiar with the particular shop's practice, but entirely independent, and who, also, has an opportunity to study the machines in operation in both the machine shop and the factory.

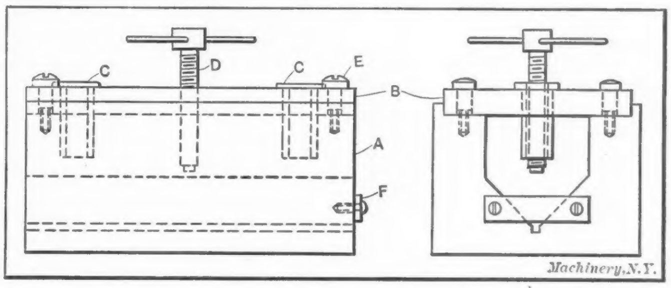


Fig. 2. Jig with Removable Top and V-shaped Locating Surfaces, for Drilling Shaft Ends

A great help in production of work of this kind is to have an equipment of reference gages for press, running fits, etc., standard reamers and tram-rods for bores or parts of large diameters. It sometimes helps to economize by combining several operations on different machines in one jig, and further on some illustrations of this will be presented. Once in a while a job will present itself in which the first number of duplicate parts required will run up in the hundreds, and then a dozen pieces that are duplicates are required at frequent intervals. This, of course, allows the expenditure of a little more money to decrease the first cost of

* For additional information on this subject, see the series of articles on Jigs and Fixtures which began in April, 1908, and other articles referred to in connection with the first installment of this series.

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production, thereby giving a little better price to succeeding pieces.

The writer will, in the following illustrations, endeavor to present a number of simple jigs covering various operations. It is not claimed that there is anything strikingly original about these jigs, but simply the adaptation of simple means

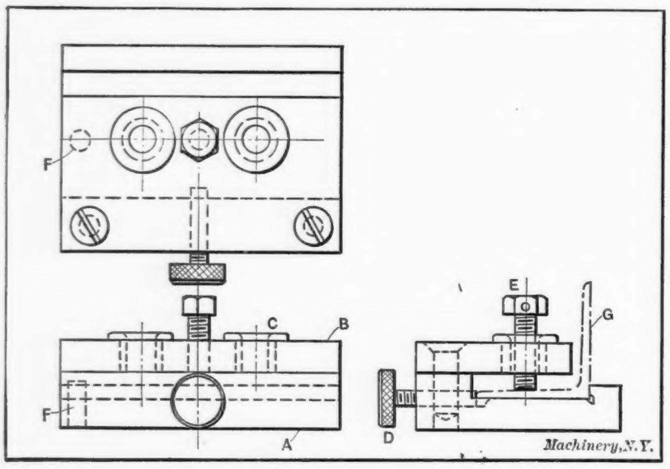

Fig. 3. Simple Jig for Drilling Accurately-spaced Holes in Angle-iron

to produce interchangeable work. It is also intended to include in this article some examples of simple lathe and boring mill chucks, which, while they are not, properly

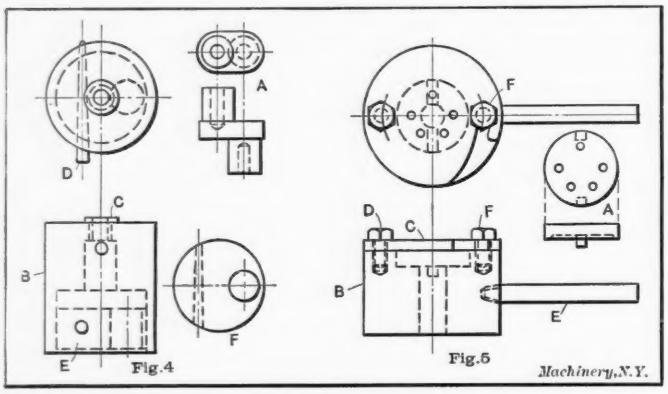

Fig. 4. Ingenious Form of Jig for Drilling Crank A

Fig. 5. Jig with Hardened Plate which guides the Drill and clamps the Work

speaking, jigs, are an important aid to the production of interchangeable parts.

The jig illustrated in Fig. 1 is for drilling two holes at the ends of a piece of shaft, and, as may be seen from the illustration, it is of the simplest construction. The body *A* is of U-section and in it holes are drilled to receive the work. Two holes are drilled at right angles to the shaft openings, and are counterbored to receive the bushings *B*. The shaft is clamped by screw *C*, and located by stop *D*. It may be worth mentioning that the body was made of an old casting which happened to be available, and the same thing is true of several of the other jigs illustrated. It is a distinct advantage to use patterns of machine parts to make jigs of, if possible, and in a fairly large plant with a variety of machines, the number of patterns that are available for such purposes is surprising.

Fig. 2 is a sketch of a jig that was made to accomplish a purpose similar to that of Fig. 1, but it has an advantage that will be noted. The surface against which the work is clamped is V-shaped, and the body *A* is provided with a removable top plate *B* in which the drill bushings *C* are located. This plate may be taken off and another one substituted with a different size and spacing of drill bushings, thus making the jig available for one or more jobs. In this particular case, it was possible, by this method, to use this jig for over twenty-five similar pieces of work. The fitted screws *E*, locate the various plates *B*, while *F* serves as a stop for the work.

The writer is aware that there are various simple adjustable center distance jigs that could be devised, but his experience has been that it is rarely possible to produce duplicate work economically with unskilled labor when using such jigs. It is almost impossible, without the use of precision measuring tools, to adjust a jig twice alike, whereas by the use of the plate *B* in Fig 2, an error made in the plate is not increased in the work, measuring is avoided and there is not the possibility of having the errors one way one time and another way the next.

In Fig. 3, we have another extremely simple jig that serves its purpose excellently. It is used to drill an angle iron in which the holes must be accurately spaced. *A* is the body, *B* is the cover containing the drill bushing *C* and the clamping screw *E*, and *D* is also a clamping screw with a knurled head. The angle iron *G* is placed against stop-pin *F* preparatory to clamping.

In Fig. 4, the extreme simplicity of this jig is its principal charm. It is used to drill a hole in each end of the lubricator crank *A*. The drill bushing *C* is centrally located at the top of body *B*. Beneath this bushing there is an enlarged hole to accommodate one leg of the crank. The other leg is placed in the piece *E*, which is shown in plan at *F*. This piece *E* is held in place by the dowel-pin *D* and it is a neat sliding fit in body *B*. The hole drilled in the body just under the bushing *C* is to allow the chips to escape. Incidentally, it should be noted that this jig represents about three hours' time for its construction; it paid for itself on its first job.

A jig is shown in Fig. 5 that is built on a different principle. It was designed to drill the pneumatic valve shown at *A*, which is a disk having five 1/8 inch eccentric holes and two lugs. It is finished on one face, on the side, and on the small surface shown on the other face. To drill the disk, it is placed in body *B* which is counterbored to fit it and which has corresponding recesses to receive the lugs. The cover *C*, which is hardened, acts both as a series of bushings and as a clamp. This cover is rotated on the screw *D* to permit the removal and replacement of work. The opposite screw *F* clamps the cover securely in position after the work is in place. A half-inch pipe handle *E* is provided simply for the operator's convenience.

As noted in the first part of the article, some jobs call for a considerable number of duplicate parts and permit the construction of a more complicated jig. This is illustrated by Fig. 6. The requirements call for four holes of different sizes to be accurately drilled in a machine steel link. This is a fixture with an eccentric clamping device of original

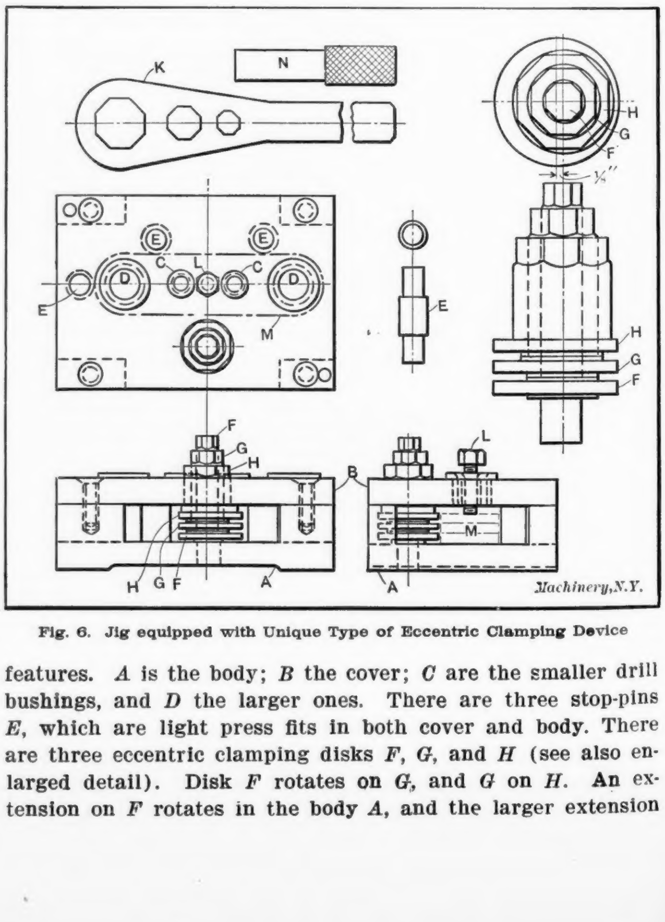

Fig. 6. Jig equipped with Unique Type of Eccentric Clamping Device

features. *A* is the body; *B* the cover; *C* are the smaller drill bushings, and *D* the larger ones. There are three stop-pins *E*, which are light press fits in both cover and body. There are three eccentric clamping disks *F*, *G*, and *H* (see also enlarged detail). Disk *F* rotates on *G*, and *G* on *H*. An extension on *F* rotates in the body *A*, and the larger extension

of H in the cover B. There is an octagon on the end of each disk spindle, and a wrench K with corresponding holes to fit each. The links M to be drilled are shown in position, three being drilled at one time. This arrangement of eccentrics gives an independent side clamp for each link, thus allowing for any irregularity in width. The clamping screw L has an octagon head to fit the smallest hole in wrench K. A plug N is placed in the first of the larger holes drilled, to prevent the pieces from working when drilling the other holes, although the work has been satisfactorily done without it.

In Fig. 7 there is shown a casing for a reversing mechanism and in Figs. 8 and 9 two jigs, the former being a boring mill jig, and the latter a drill jig for drilling the flange holes in line with the bearings. The casing is composed of three parts: A, B, and C. As will be noted, this casing has four bearings in it, two of different sizes in A, one in B of the same size and in line with the smaller bearing in A, and one in C, in line with, and the same diameter as, the larger bearing in A. The holes at X and Y are for fitted bolts, used instead of dowel pins, and the other ten holes shown are clear-

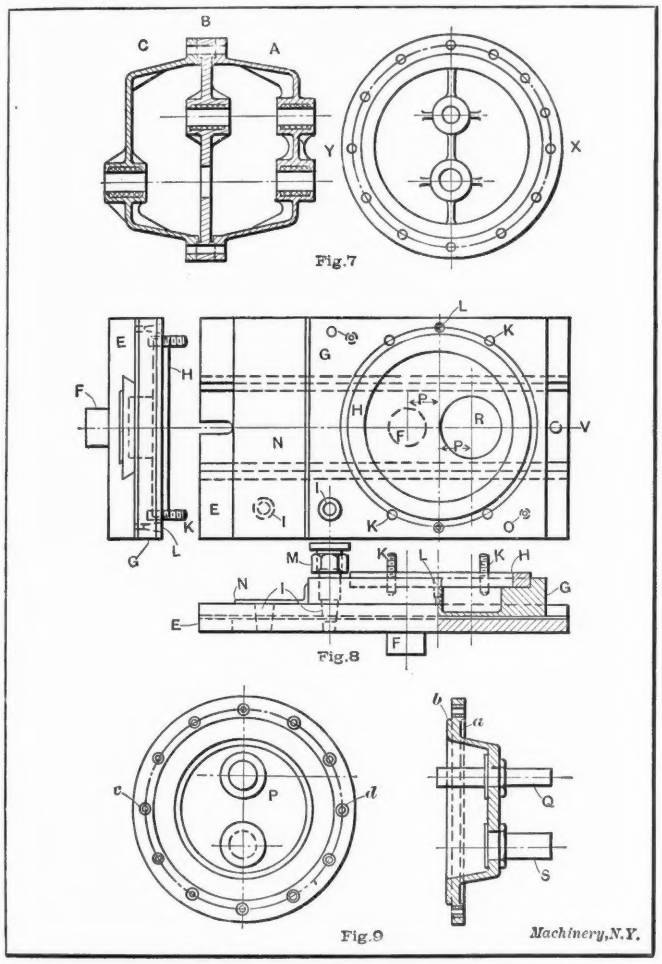

Fig. 7. Casing with Drilled Flanges and Bored Bearings. Fig. 8. Jig in which Bearings are bored. Fig. 9. Jig in which Flanges are drilled

ance holes for through bolts. As will be shown later, the fitted holes serve a double purpose. The casings are made male and female at the joints, and these are turned to close limits, A and C being alike, and B fitting into them.

In order to properly set forth the features embodied in these designs, it will be necessary to describe the boring mill jig, then the drill jig, and afterward give a short description of the operations. In Fig. 8 E represents the body of the boring mill jig, in which there is a tapered slide on the top side, and a pin F on the other side to fit the hole in the table of the boring mill, thereby centering the body E. The slide G works in and is closely fitted to E. This slide is counterbored to fit the male part of the joint in casings A and C on the longitudinal center line and midway between the bearings in the casings. The removable ring H is closely fitted to G and projects just enough above G to fit the female joint on part B. By removing H, G becomes the opposite of the joint on A and C.

Two tapered holes I have a center-to-center distance equal to that of the bearings in the casings. Four removal studs K are made somewhat smaller than the bolt holes in the flanges of the casings to hold the latter in position after they are located in the jig. There is a tapered hole L on each side of G, and these serve to center the casings and always bring the bearings in the same relative position. The pins are parallel and closely fitted where they go through the casings, and

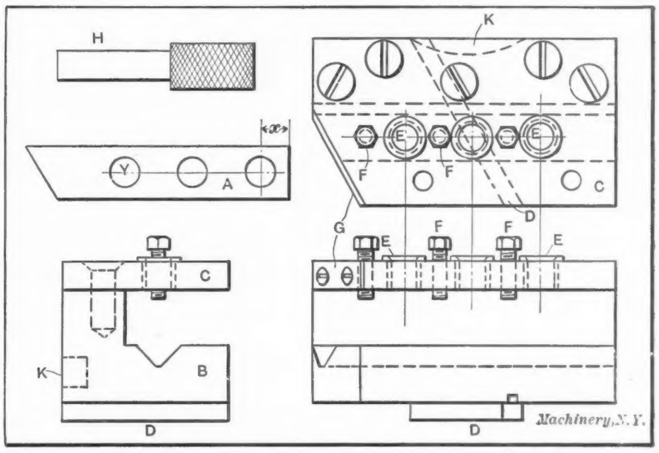

Fig. 10. Combined Drilling and Milling Jig for Part A

tapered below that to fit the holes L. A tapered pin M fits holes I, and is parallel where it goes through G. The nut shown is for the purpose of releasing it; the head is simply a projection to allow M to be securely driven into G. The locating pin that fits the tapered hole L, and also the reamed holes X and Y (see Fig. 7) in the casings, is similar in construction to M, but smaller. A protection strip N prevents chips from getting into hole I, and the working part of the slide E. R is simply a clearance hole in G for the bearings.

In the drill jig shown in Fig. 9, the casing P is the principal part. This casing is recessed at a to correspond to the male part of the joint on casing A and C and at b to fit B. The pin Q on the inside of the jig fits the bearing in B, and on the outside the small bearing in A, while S fits the large bearing in A or C. When drilling C, pin Q is removed. There are twelve holes with bushings shown; the two at c and d are removable to allow smaller bushings to be inserted, in order to first drill and then ream these two holes for the fitted

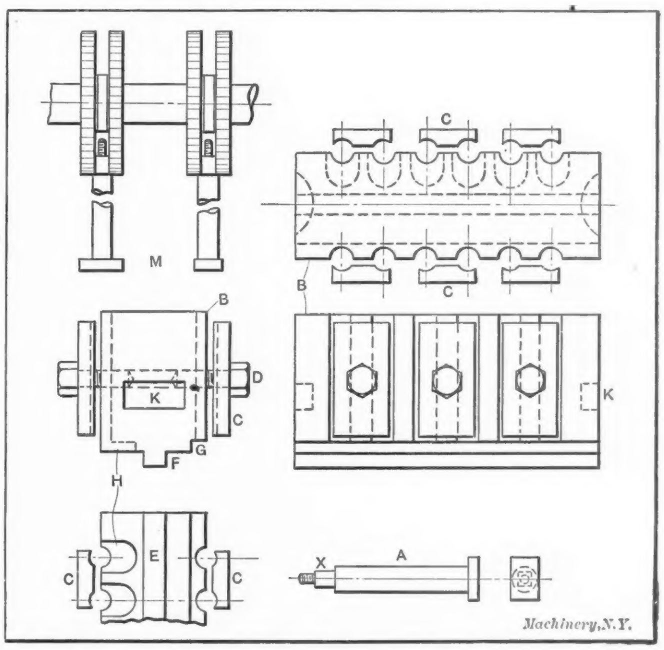

Fig. 11. Fixture for Milling Square X on Bolts A in Correct Relation with Rectangular Heads

bolts previously referred to. A brief description of the boring and drilling operations will make clear some of the uses of various parts of these two jigs.

When machining a new set of casings, the studs K are removed from the boring mill jig, and placed in the tapped

holes O, and the ring H is also removed. The casings A and C are first finished on the faces of the flange and tongue, and the bearings rough babbitted. Either casing A or C, as the case may be, is then placed in the boring jig, and the bearings approximately lined up with the center line V. The casing is then clamped on the jig by means of U-clamps placed over the studs K in the tapped holes O. The bearings are then bored; first the one in line with F, and then the other, after the slide is shifted to the next location by inserting pin M in the other hole I. The drilling jig is now placed on the casing and pins Q and S are inserted in the bearings, thus locating the holes in the flange with reference to the bearings. All the flanged holes are drilled and holes X and Y are reamed. In case of repair to the bearings, the casing A or C is located on the boring jig by the pins that fit into the reamed holes X and Y, and in the tapered holes L in the slide G; the casing is then clamped by means of studs and nuts K in position in the boring mill jig. Thus one jig

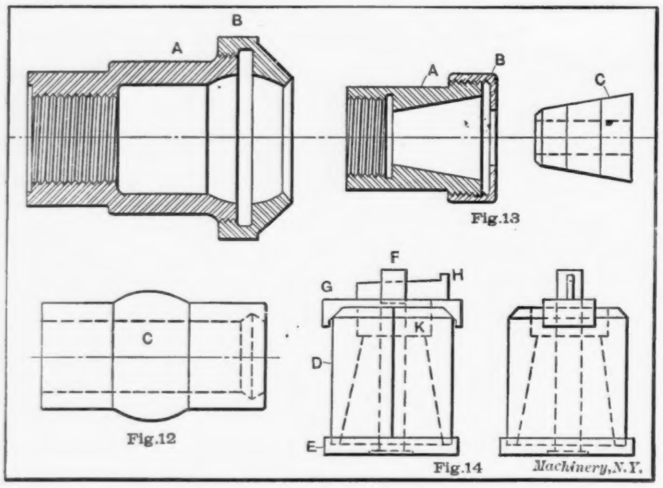

Fig. 12. Simple Chuck in which Bearing C is bored. Fig. 13. Chuck for Boring Part C. Fig. 14. Babbitting Jig in which Part C is cast

is dependent on the other. When casing B is to be bored, the ring H is placed in the position shown in Fig. 8, and then the operation is the same as described for A and C. By the use of these jigs, it is possible to produce new work or repair the bearings in the old casings at any time, and they will be interchangeable. The bearings are, of course, bored to gage.

In Fig. 10 we have an example of a combined milling and drilling jig. The work A consists of a round piece of tool steel, one end of which is to be milled at an angle and accurately spaced from the center lines of three holes to be drilled; the distance x on the work is immaterial within 1/8 inch. B is the body of the jig, having a V-slot cut in it to center the work, and a recess K in the back to clamp it to the table of the machine. A clamp on the other side rests on the jig near the V-groove. In the top-plate C the drill bushings E, and the clamping screws F are located. A removable piece D is recessed into B and made to fit the table slots in the milling machine, thus setting the work at the proper angle; during the drilling operation this piece is removed. The milling cutters are set against a hardened strip G to secure the proper distance from the center line of the first hole and the angle of the cut. After the stock is cut off with a power hack-saw it is clamped in the jig a certain distance from the last hole in the end; this distance is equal to X with an allowable variation of one-eighth inch. The hole Y is first drilled, and then the plug H is inserted to prevent the work from moving. The other holes are then drilled. After the required number of pieces are drilled, the piece D is fastened to the fixture, which is clamped to the milling machine table. The end of A is then milled, plug H locating the holes with reference to the cut.

Fig. 11 shows a milling fixture in which the work A is milled square at X, and at a certain relation to the rectangular head. The body of the fixture is recessed on its sides to a depth equal to half the diameter of the bolt. It is also recessed on the bottom at H to correspond to the longer side of the rectangular head, and at G to fit the shorter side. This is shown plainly at E. The bolts are held by clamps C and clamping screws D. A projection F fits the table of the milling machine. Recesses K on each end of B are used to clamp the fixture to the table. The first and second settings of the bolts are clearly shown by the diagrammatical view at M, making further explanation unnecessary.

A simple chuck is illustrated in Fig. 12 for boring the bearing C. This bearing is first turned all over on the outside by a forming tool and then mounted in the chuck. The body of the chuck A is threaded on one end to fit the spindle of a 16-inch lathe, and it is bored out on the other end to fit the parallel end of C. B is a cap screwed onto A and bored to fit the spherical part of C. Thus when C is placed in chuck A and cap B screwed home, it clamps the work on the spherical part; the parallel part is also effective in centering the work. This chuck is extremely simple, yet very efficient.

The chuck shown in Fig. 13 is similar to that in Fig. 12, except that the work is tapered, C being the work, A the body of the chuck threaded to fit a 16-inch lathe, and B the clamping cap. As the work, in this instance, is of composition, the babbitting jig used will be of interest and is illustrated in Fig. 14. The base E is counterbored on the under side to receive the head of pin F, and on the top to fit shell D. This shell is split through the center and tapered at the top to correspond to the taper on G. Pin F, which acts as a core, is slightly tapered, and has a slot in the top so that by driving the key H in, G, D and E are securely clamped together, making a solid box. By removing H, the box falls apart and F is easily driven out of the work A. The parallel part K of the top is to allow chucking in the lathe for forming.

In summing up, the important points to be observed in repair shop jig design, are: (1) Simplicity; (2) minimum cost; (3) ease of operation consistent with cost; (4) use of machine parts or patterns already made, in designing fixtures, when only slight modifications are necessary; (5) the co-operation of the machine designer to secure simplicity in parts; that is, a number of simple pieces in preference to one complicated piece of mechanism, thus helping the shop side of the question; (6) the combination of a number of different machine operations in one fixture, if this can be done at a minimum cost, as a small loss of time on the machines, due to changing, is not noticeable in comparison to a high fixture cost for a few pieces of work; (7) comparative interchangeability; that is, good enough for the intended work but no more, as going to extremes in this line of work is particularly objectionable.

* * *

It appears that Australia intends to take a prominent place in the development of aerial navigation. A consular report states that Messrs. Walter Thompson and F. A. Boyd of Perth, West Australia, have developed certain designs and models for aerial navigation machines, including, among other inventions, a novel steering apparatus, a "fulcrum" by which an aeroplane floating and soaring in the air will maintain a condition of perfect equilibrium, and a simple and safe design, making it possible to attain speeds with aeroplanes higher than those hitherto attempted. A company has been formed in Australia, and a member of this company has left for England in order to exploit the inventions there. With no other details than those above at hand, it is, of course, impossible to say whether or not the inventions are of practical value and importance.

* * *

Perhaps there is no other feature of marine architecture about which there is so much doubt as the propeller, nor any feature more important to-day in the matter of efficient propulsion. An excellent illustration is the recent improvement made in the Cunard steamship *Mauretania*, by the change in her low-pressure propellers from three blades to four blades. They were made with other changes in design in accordance with a formula deduced by one who made a special study of the subject. The increase in speed is remarkable considering that the *Mauretania* had already exceeded the limit imposed by the contract of the Cunard Co. with the British government.

NEW SPUR GEAR GENERATING MACHINE

JOSEPH G. HORNER*

A new spur gear generating machine (the Sunderland patent) is being manufactured by Messrs. J. Parkinson & Sons, of Shipley, Yorkshire, England. There are several bevel gear generators in the field, but few as yet for spur gears, the reason being that the objections to the use of single rotary cutters are not so great when spur gears are cut as when they are applied to bevel gears. Still, the growing demands for teeth of ideal accuracy for high-speed

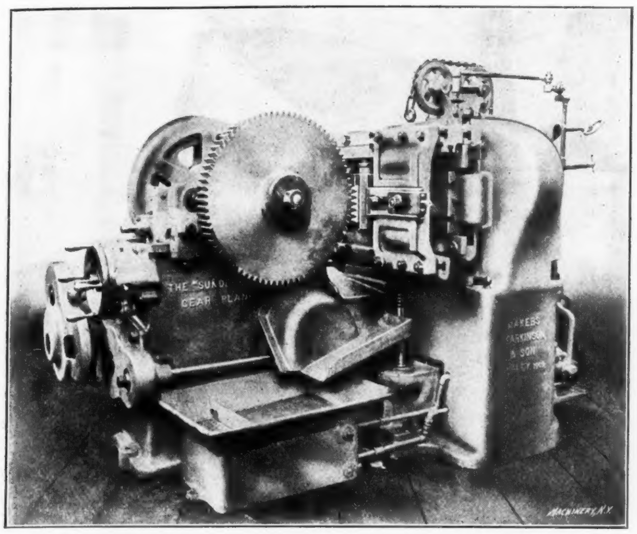

Fig. 1. The Sunderland Patent Spur Gear Generating Machine

gears includes spur teeth, and the use of the single rotary cutter introduces elements of slight inaccuracy which are inconsistent with the ideal. The Fellows' machine has been familiar for many years, but the greatest impetus to generated spur gear teeth was given about three years ago when German designs of machines for generating these gears by hobbing were introduced. This lead has been followed extensively in England and the United States. The Sunderland spur gear generating machine is designed to avoid the difficulties which have arisen in the operation of the hobbing machines. These were principally the cost of hobs,

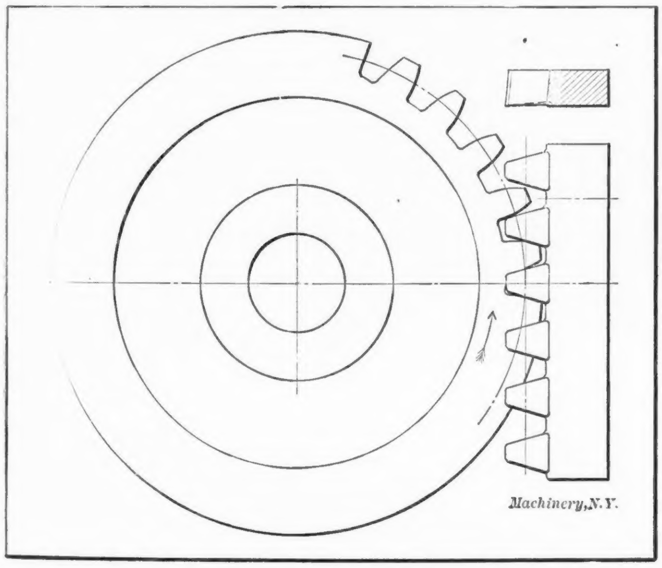

Fig. 2. Diagram Showing Action of Rack-cutter in the Sunderland Gear-cutting Machine

which is high, due to the difficulties in hardening and grinding them, and to the heat generated in heavy cutting, which results in inaccurate gears. In the Sunderland machine a rack-shaped cutter is employed, containing six teeth hardened and ground. Its cost is only about one-fifth that of a hob, it is easily re-sharpened, and less heat is generated in cutting, while increased output is claimed.

* Address: 45 Sydney Buildings, Bath, England.

The rack cutter, of involute type cuts, of course, all gears of the same pitch, all meshing accurately with each other and with a rack; and the results are more accurate than those obtained by single rotary cutters, or by planers controlled by a former, while one cutter only is required for one pitch instead of a series of rotary cutters, or a series of formers. The rack cutter is mounted on a slide which imparts a reciprocating motion to it, while the wheel blank, mounted on a horizontal arbor fitted in the spindle of the dividing wheel, rotates in relation to it, in unison with an upward movement of the cutter slide, as in the actual engagement of gears. The rolling movements impart the tooth curves while the reciprocating movements of the rack tool out the teeth to the correct depth. Several of these operations repeated are required to complete the teeth of the wheel. In the first position the cutter touches the edge of the blank. In the second the blank is fed in to the proper depth, while the spaces are cut by the reciprocating cutter. The heaviest work is done by the leading teeth of the cutter, and as the wheel blank rotates in unison with the upward movement of the cutter the remaining teeth are gradually relieved from strain, and thus retain their keen cutting edges longer for finishing. After as many teeth are cut as can make full contact with the rack cutter through a distance equal to one pitch, the wheel blank is withdrawn clear of the cutter, its

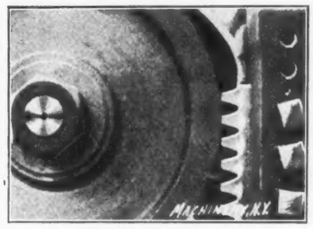

Fig. 3. First Position: Cutter just Touching Blank

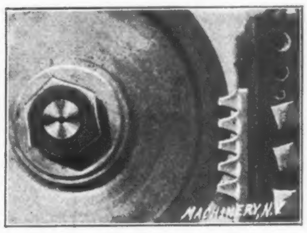

Fig. 4. Second Position: Blank Fed to Proper Depth for Teeth

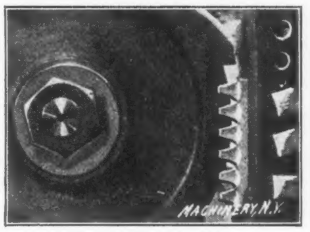

Fig. 5. Third Position: Blank and Cutter having Advanced a Distance equal to the Circular Pitch

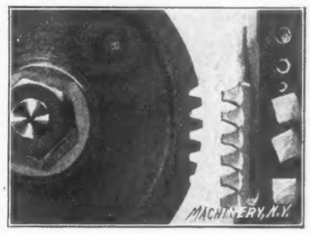

Fig. 6. Fourth Position: Blank withdrawn from the Cutter

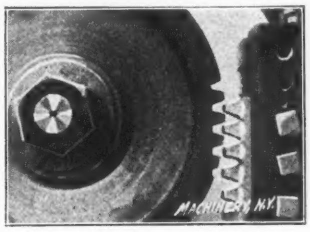

Fig. 7. Fifth Position: Cutter returned to Starting Point

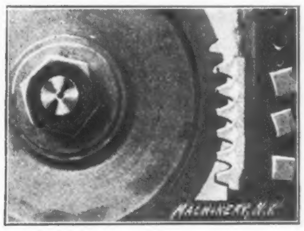

Fig. 8. Sixth Position: Blank returned to Cutting Position; beginning of Second Cycle

rotary motion arrested, and the cutter-slide returns vertically to its original position, that is, to a distance equal to the pitch being cut. The blank is then returned forward to the position for cutting, the rotary motion is re-started simultaneously with the upward movement of the cutter-slide, and another cutting cycle repeated. These movements are automatic until the wheel is completed. Only two sets of change-gears have been set up, one for the number of teeth to be cut, and the other for the pitch. Cutting speeds can be varied from about 20 feet to 40 feet per minute. The various speeds are obtained in the machine itself, so that the machine is driven by a constant-speed belt from a line-shaft; or it can be arranged for a motor drive. A pump and circulating pipes are fitted to the machine.

The machine cuts gears from 3 inches to 24 inches in diameter, and pitches from 8 to 2½ diametral pitch, and widths of faces up to 8½ inches. It weighs 3½ tons.

Entered at the Post-Office in New York City as Second-Class Mail Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

49-55 LAFAYETTE STREET, CORNER OF LEONARD, NEW YORK CITY.

Alexander Luchars, President and Treasurer.
Matthew J. O'Neill, Secretary.

Fred E. Rogers, Editor.
Ralph E. Flanders, Erik Oberg, Franklin D. Jones, Ethan Viall, Associate Editors.

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FEBRUARY, 1910

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

GROWTH FROM SMALL BEGINNINGS

The machine tool industry is remarkable in the fact that it is a growth from small beginnings. In mentally reviewing the history of the firms which have been successful in that line, we do not call to mind one which made a flying start with large capital and highly developed organization behind it. These phases have come later. The original start was made from humble beginnings, often by men working at the lathe and the bench.

This hopeful condition is due, possibly, to the high plane of development which machine tool design has reached in this country. The plane is so high that the product which is to meet competition successfully must have behind it a *personality*, brimming with enthusiasm and original ideas. Such personalities are self-selective. They rise to the top like the cream in the milk pitcher. They are not usually attracted by complex organization and powerful resources.

* * *

A DEFECT IN THE SALES DEPARTMENT

Almost every enquiry a manufacturer receives has some value—the actual value depending largely on the way the enquiry is handled. Comparatively few advertisers so handle their enquiries as to get the greatest possible return from them. Some are content with sending a catalogue or circular, and possibly a form letter, which they never follow up, although in many cases a purchase is not made for months after the enquiry is sent in. Other manufacturers, particularly of automobile supplies and office appliances, it is positively dangerous to write to, because the name of the enquirer is immediately placed in a species of mill which proceeds to grind out long follow-up letters, the intent of which is apparently to make life a burden for the unfortunate enquirer, and in time to force him to buy. There must be a reasonable mean between these two methods, and it can be found in the intelligent handling of enquiries by a trained office man who thoroughly understands his business, and not by a typewriter who is handed a list of names to send form letters to.

If the manufacturer considers the amount of money which is often spent in trying to effect a sale, he can quickly figure out that it will pay to handle enquiries intelligently. An instance of the lack of this quality is mentioned by a well-known machine tool dealer who writes us:

A manufacturer will send us prices and quote us discounts, and we take an order and send it in. In the meantime he has made some exclusive agency arrangements with another house covering this territory, and we are politely informed on receipt of the order that they can't fill it on account of these arrangements. Our salesman has lost his time and we have lost ours and we have talked up a deal for the benefit of one of our competitors, as we have to notify our customer that we can't fill the order. There are not so many machine tool dealers in the country but what manufacturers could, without overexertion on their part, keep them posted as to their sales arrangements, and also on their new designs by sending out up-to-date printed matter. The majority of the new catalogues that we receive we have to ask for, although when a manufacturer gets out anything new one day's work in his office would suffice to supply all the machine tool dealers in the country with this information. The greatest assistance we get is through the medium of the trade journals, and this gives us the opportunity of thanking you very much for keeping us posted in the manner you do.

* * *

TECHNICAL LITERATURE

It does not seem to be an exaggerated statement that at least fifty per cent of the technical books brought out to-day in America have been written merely to satisfy the ambition of an author who wants to see his name on the title page of a book, and published simply because the publisher expects to make a profit on the book, and for no other reason. A great many technical books are practically nothing but abstracts and compilations of other books previously published, containing hardly anything that is new and original, not even in the treatment or arrangement of the matter; and in some cases these new books are even inferior to works that have been previously published. Such books have, therefore, no excuse for their existence except the ambition of the author and their money-making possibilities.

Technical books of real merit are few and far between. In this respect a decided difference has been noted by many book reviewers between German and American books. German technical books and English as well, are noted for their thoroughness, logic and originality. The "padding" so common in many American works, is almost always absent from German technical publications. The German mind especially appears to be particularly adapted for arranging the material properly, systematizing it in such a way as to lead the reader or student from subject to subject by easy stages, and provide him, at the end of the journey through the book, with a clear, comprehensive conception of the subject treated.

There have been many reasons advanced for this difference between German and American books. The most plausible is that the "hustling" of American life shows itself in its technical literature. It is produced in haste, and too little attention is given to detail. Perhaps this is because many of our books are not the works of authors with ample time for investigation and study, but of actual workers in the industries who cannot give a large portion of their time to book writing. This last feature is one of the redeeming characteristics of some American technical books. Written by men actually engaged in practical work, with all their faults of illogical arrangement, unbalanced contents and lack of comprehensiveness, they are more practical, more thoroughly in touch with the industrial conditions, and better adapted to the use of the every-day man, than the more thorough-going and comprehensive German works.

The demand for books written in the popular style is perhaps accounted for by the limited educational advantages of a large number of technical book buyers, represented by the workers in every trade; but even this feature presents no excuse for the production of books which are simply "hashed over" from the writings of other authors, because a popularly written book is capable of just as logical arrangement and even more original treatment of the subject than a more scientific treatise.

WHEN TO SAFEGUARD MACHINERY

Machine designers, manufacturers, and others concerned with the production of machinery are slowly awaking to the fact that it is not good design or business policy to put machines on the market having unprotected gears and other danger points. The movement for greater safety in industrial pursuits has already had a marked effect on machine design, but there is still great need of improvement in this respect, in the construction of many classes of machinery. In an editorial in May, 1907, we made a point of the fact that the time to safeguard danger points in machinery is when the design is on the drawing-board. The designer can cheaply and effectively provide guards in the original design of the machine, whereas they might be cumbersome or entirely out of the question after the machine had been built in the ordinary way. We suggested that "safety of operation should be placed on a par with mechanical efficiency, and that our schools of mechanical engineering could do no greater service for the manufacturing interests of the country than to instil this principle in the minds of their students."

Mr. R. C. Bolling, of the United States Steel Corporation, at the recent annual meeting of the Museum of Safety and Sanitation, New York, spoke of the difficulty of providing effective safety devices on machinery that had not been designed for them. He said that the United States Steel Corporation, which is spending about $1,000,000 annually for accident prevention and compensation to injured workmen, has experienced great difficulty in protecting danger points on machines, cranes and other appliances that had been unprovided with these desirable accessories when built. In fact, it was practically impossible in some places to provide railings for runways and protection for gears, because of lack of clearance, etc. Such provision would have made necessary the re-construction of roofs, changes in foundations and in the whole lay-out of the mill, amounting practically to a reconstruction of the plant. Mr. Bolling said that almost all the machines, cranes and other apparatus could have been adequately protected in the original construction with little or no additional cost; but when provided afterward the expense was very heavy.

We reiterate that the time to safeguard machinery is when it is on the drawing-board; and designers should awaken fully to a sense of their responsibility in this respect. They should consider safety as of equal importance with operating efficiency, for if the machines, unprotected, are not safe to work, they are failures, no matter how efficient they may be as producers. Finally, manufacturers and all users of machinery should fully comprehend the significance of the Museum's motto: "Prevention is a benefaction—compensation an apology."

* * *

THE AUTOMATIC MACHINE AS A CIVILIZING AGENT

It is the fashion among certain critics of the present social order to cast aspersions on the automatic machine as compared with the hand processes which it has displaced. The old idea that it throws workmen permanently out of employment has been pretty thoroughly exploded; but there still remains a vestige of the ancient superstition that ingenious inventions tend to degrade labor. It is claimed that the workman becomes a part of the machine, performing in unison with it the few movements of feeding or adjustment which it is impracticable for the machine to perform by itself.

With this unfriendly view of the automatic machine we boldly take issue. There are without doubt many instances in which the criticism holds good, but this condition is only a passing phase of development. The application of automatic feeds, for instance, has relieved and will continue to relieve the operator of tiresome routine work. We shall eventually change our belief that the only mechanisms which can successfully be made self-acting are those which may be operated by unskilled labor. The time is approaching when mechanisms will be found profitable which require the attention of mechanics of the very greatest skill and experience. As the field thus broadens, mechanics of all grades of ability will become more and more engaged in the work of supervision, instead of being bound to the monotonous repetition of manual movements required for hand work or machine feeding.

The continued development of the automatic machine holds out hope to the workman for relief from much that constitutes the drudgery of labor.

* * *

SALARIES VS. PROFITS

A STUDY IN SHOP AND OFFICE MANAGEMENT

POLYCON

The draftsman, usually, has an excellent opportunity to study methods of shop management and general business systems. Except in some of the largest establishments, he has free access to the shop, and usually avails himself with more or less freedom of the opportunity to study shop methods and, incidentally, to break up the monotony of close confinement to the drawing-board. His work, too, brings him more or less into contact with foremen and workmen, and he is thus in a position to learn the shop view of matters with some degree of accuracy. In addition to this, the drafting-room being a sort of neutral ground between shop and office, he is often able to get something of an insight into office methods, more particularly as regards the ordering and cost-keeping departments. It has been the writer's fortune, good or bad, to have wandered considerably, and to have been employed in establishments doing a wide variety of business, from pure manufacturing to pure engineering, including various admixtures of these two extremes. Although making no pretensions to speak authoritatively on the subject, I have always been rather a close observer of shop management, and a comparative description of some of the systems I have seen might be of interest.

Cost Systems

Shop *A* was engaged in the manufacture of gas and steam engines and boilers for use in the oil fields, besides making general oil-well supplies and attending to repair work. The shops were modern and employed about four hundred men, and the output was limited to a few standard sizes. The cost system was handled by one clerk, and there was one foreman to each of the usual departments, machine, forge, foundry, pattern, and boiler shops. The stock was kept by a young man, and was delivered to the workmen as required, on an order from the foreman.

Shop *B*, where I was employed immediately after leaving *A*, was engaged in exactly the same line of work, with the addition of a general line of plate work, such as tanks and pen-stocks, and the development of a line of larger sizes of gas engines. On account of these latter branches a large force of draftsmen was maintained, while in the previous position I was alone in my glory. The number of men employed was but inconsiderably greater than in the case of *A*, but the cost department included three or four clerks, all of whom appeared to have enough to do, and each foreman had a clerk. In order to get a piece of drill steel or a machine screw from the stock-room, it was necessary for the workman to get an order from the foreman, take it upstairs to the cost department to have it signed, and then get the material from the stock-keeper, who, by the way, also had an assistant.

Now it is significant that while the *A* company was paying a good dividend to the stockholders and was also able to give its employes, as a Christmas present, a substantial bonus based on their wages, the *B* company not only was not paying dividends on the stock, but was in actual financial difficulties. I do not say that the elaborate cost system was the sole cause of the trouble with *B*, but I do believe that a simpler system would have been sufficiently accurate for the purpose, and would have saved thousands of dollars yearly.

Office Systems

The first establishment under this heading, *C*, was engaged principally in the manufacture of mining and ore-handling machinery, and had modern and well equipped shops employing five or six hundred men. Having a well-established business, the selling was done chiefly by correspondence and by one or two supply houses in the mining districts, beside which the general manager and engineers

took occasional trips when something "big" was in the air. The business of this company was handled by the president, general manager, treasurer, and purchasing agent, with a staff of clerks and stenographers not exceeding five. All of the above officials, as well as the superintendent and some of the engineers, were stockholders in the company, were receiving satisfactory salaries, and there was a spirit of hearty cooperation evident among them.

Company *D* was also engaged in manufacturing, mining and ore-handling machinery. The office building was a handsome four-story structure, and the shops, employing about the same number of men as *C*, were well built and equipped with the most modern tools and appliances. This company had a president, general manager, works manager, secretary, treasurer, purchasing agent, auditor, sales manager, two vice-presidents and a chairman of the board of directors, most of whom were relatives of the original members of the firm and drew large salaries, their assistants, in some cases, doing the work.

It is not difficult to understand that while *C* was paying dividends, *D* was not, and further, was in serious financial difficulties. Both companies maintained large and efficient engineering staffs, had well-equipped shops and an established reputation in their lines of business, and it could not but be patent to the most casual observer that the profits in the case of *D* went to pay large salaries to supernumeraries.

Shop Systems

The next shop to be considered, designated as *E*, was one which had grown from a jobbing shop and, at the time that I worked there, employed about four hundred men, building steam engines, boilers, mining machinery, saw-mill and pulp-mill machinery, and general plate work. The buildings were frame structures, inadequate for the work, and the tools were—some of them—fit only for the scrap heap. However, there were some good, heavy machines, and, with good management, the plant should have been capable of producing a fair output. As stated, the shops had grown from small beginnings at a time when business was plentiful and prices good, and the company had always been able to pay good dividends. Being a close corporation, practically owned by three men actively engaged in the management, one of whom was the general manager, a sharp eye was kept on the balance sheet. This being so, it seems strange that the shops were not maintained in a more efficient state, but, on the contrary, the manager's sole idea of economy seemed to lie in the reduction of expenditures. In order to get the work out cheaply, all sorts of patchwork was done on the patterns, metal was skimped to the limit, an excess of scrap and a low grade of pig was used, and the machinery was often shipped out only half finished. All through the shops an excessive number of apprentices was employed, and laborers were doing work which should have been done by skilled mechanics; in the office, the highest salaried man outside of the general manager and the treasurer received $150 a month. At the same time, the cost system was only used to obtain the total cost of a new size or design of machine; it gave no idea of where the loss or profit occurred, and was not followed up for duplicate machines. The natural result of these methods was that this concern was losing more in bad castings and mistakes than was saved by the false economies, and continually the few good workmen employed would leave because the firm was not willing to pay them as much as someone else would pay.

In sharp contrast to this was plant *F*. Here the spirit was to do the kind of work best suited to the requirements, to improve the equipment as fast as financial conditions would warrant, to pay such wages as would attract and keep the best men, and to keep down costs by finding out exactly where losses occurred and then rectifying the conditions causing the loss. Each month an accurate and complete statement was made up, showing the number of men employed and their wages, the cost of material consumed and the output, with a comparison with previous months. The foundry had to make a daily report of all castings, giving the names of the molders whose castings were spoiled and the cause thereof, and every foreman was made to feel that he was there to improve the output in quality and reduce the cost.

Conclusions

And now to point the moral! Not that it is necessary to do so, for it seems as if the conclusions were self-evident. However, the officers of any corporation owe it to the stockholders to so conduct the business as to pay a reasonable profit in the form of dividends. Too many corporations are like *D*: they pay large salaries to the officers and provide remunerative and not-too-laborious employment for sons and sons-in-law. Others, with perfectly honest intentions, are overburdened with systems or are swamped by an overweening vanity on the part of the officers, manifesting itself in elaborately-fitted offices and lavish but ineffective advertising. Still others are being wrecked by incompetent or too daring engineers, who undertake unusual contracts without sufficient investigation of the conditions and requirements, with the result that the work as finally designed over-runs the estimate excessively.

The best results, however, would be obtained if the order and cost systems were kept in the simplest possible form consistent with obtaining accurate and reliable results; the same rule should apply to the business management. In the shop it is good economy to pay fair wages and to insist on a fair return of work therefor. System is a good thing, but, like most good things, it is possible to have too much of it and, therefore, "be temperate in all things" is good advice in the business world, as elsewhere.

* * *

THE POWER OF LARGE GUNS

A gun may properly be considered as a prime mover, and its output may be expressed in terms of horsepower. As, however, the period of time during which energy is exerted is very short, the horsepower expressed in figures becomes rather startling. A calculation involving the horsepower of the large 16-inch gun mounted at Sandy Hook, for instance, will reveal more than anything else the enormous size and power of this gun. The projectile weighs 2,370 pounds and has a muzzle velocity of 2,300 feet per second. The energy developed at the muzzle is about 88,000 foot-tons. If we assume that the projectile moves through a distance of 33 feet within the gun while acquiring the given velocity, and that the acceleration of the projectile is uniform until the muzzle is reached, the mean velocity of the projectile while within the bore would be $\frac{2,300}{2} = 1,150$ feet per second, and the period of time during which the energy of 88,000 foot-tons is developed would be $\frac{33}{1,150} = \frac{1}{35}$ of a second. This corresponds to a total of $88,000 \times 35 \times 60 = 184,800,000$ foot-tons per minute. Since the horsepower = 33,000 foot-pounds, or 14.7 foot-tons per minute, we have $\frac{184,800,000}{14.7} = 12,600,000$ horsepower, as the power developed by the gun during the period and conditions mentioned.

* * *

In accordance with the factory and work-shop act of Great Britain, the British Government has issued regulations relating to safety arrangements to be used in dry grinding and finishing processes. According to these rules all grinding wheels must be provided with a hood or other appliance so constructed and arranged as to take care of practically all dust created. A duct of adequate size arranged to carry away the dust must be provided, and a fan or other effective means for extracting the dust must be installed. Suitable respirators must also be provided for all persons employed in grinding, whether working in a room or in the open air. No person is permitted to do any work other than grinding in a room where grinding is carried on, except work required for cleaning purposes. Provisions are also made for effective cleaning of rooms in which grinding is carried on, at least once a week. The employer is required to furnish all safety apparatus, respirators, etc., and every person employed is required to make full and proper use of the appliances provided.

LAYING-OUT AND ALIGNING OPERATIONS ON MACHINE TOOLS—1*

ALFRED SPANGENBERG†

In general, laying out is the process of placing such lines on castings, forgings, or partially finished surfaces, as will designate the exact location and nature of the operations specified on the drawing; an aligning operation, as its name implies, consists in lining-up a shaft bearing, bracket, or other similar machine element, in its proper place relative to other members. The first-named operation usually is associated with the process of machining, while the last-mentioned is generally included in the work of assembling. Laying-out and aligning operations may be divided into two parts: the preliminary and the final. The preliminary operation consists in approximately locating a machine element in place for the purpose of marking the clamping bolt holes on its supporting member; in the final alignment, the exact location is ascertained for the purpose of drilling the dowel pin holes, the work being held by its clamping bolts. Clearance in the bolt holes permits of this adjustment.

As the ultimate results obtained in assembling are controlled to a large extent by the accuracy of these operations, it is of the utmost importance that means be provided for insuring the refinement that the nature of the case demands. Jigs and fixtures have, of course, been a dominant factor in dispensing with much of the ingenuity and skill required in this work, but owing to special considerations a preclusion of these valuable adjuncts to manufacturing work may be advisable. In this case a simple gage or templet, or even a wooden jig provided with steel bushings, will greatly facilitate the operation of laying out or aligning, and, in fact, when proper care is exercised in using these comparatively crude devices, work may be produced on an interchangeable basis as good as with more expensive tools; although it is to be expected that more skilled labor will be required.

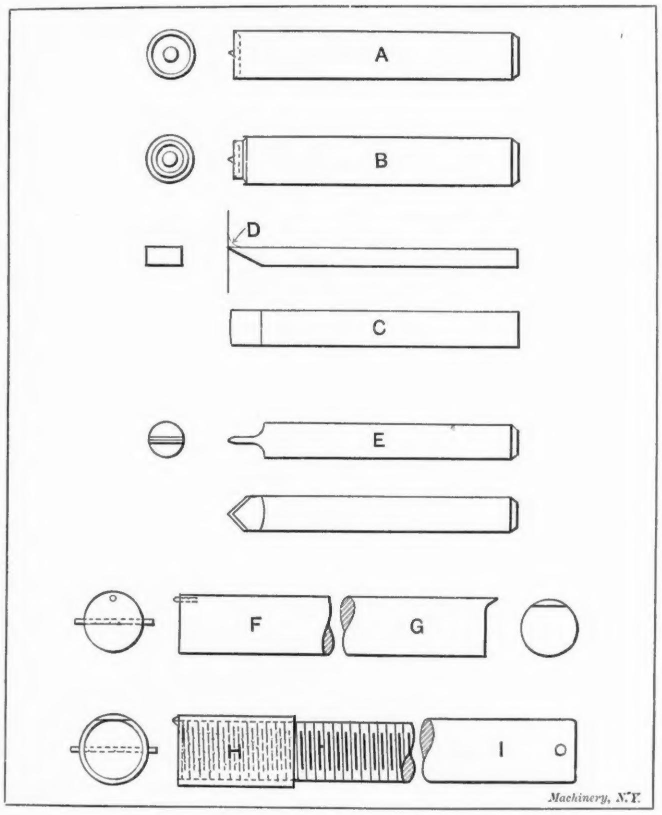

Fig. 1. Special Tools used in Laying-out Operations

As regards the different methods of laying out and aligning, no definite rules can be given. The machinist must consider the means at hand and the nature of the job; he must then use his ingenuity and be guided by his practical experience. A few special cases are illustrated in the accompanying line-engravings; the methods and processes shown and the remarks made in regard to them are intended only as suggestions of how the work may be accomplished without the employment of drill jigs. It is not to be inferred that the way shown is, in each instance, the best method possible and the only one applicable. Circumstances alter cases; while the methods shown may be eminently suitable for one set of conditions, they may either be too refined or not refined enough for other conditions and requirements.

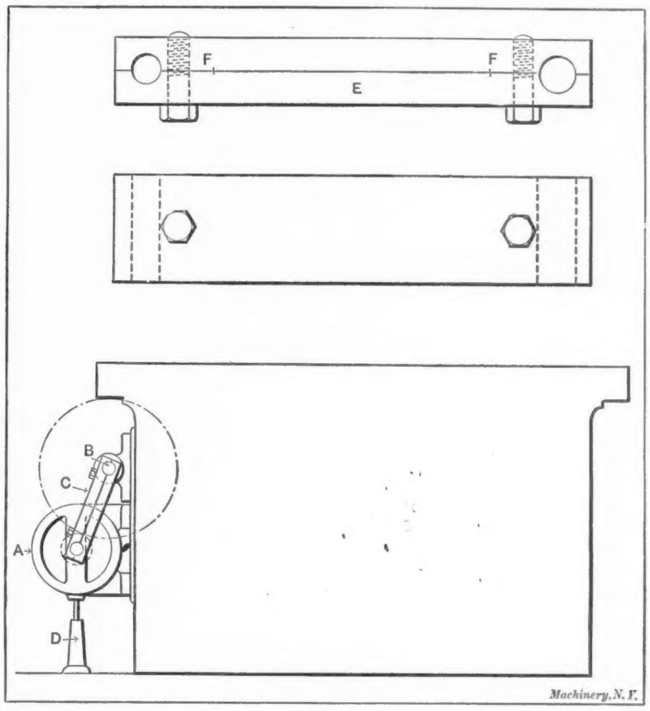

Fig. 2. Locating a Small Motor by the Use of a Link

Special Tools and Appliances

Aside from the more common laying-out tools such as the dividers, surface gage, steel scale, etc., there are a number of tools of a special form used for laying-out operations, some of which are shown in Fig. 1. The form of center punch shown at *A* will greatly facilitate marking off holes through brack-

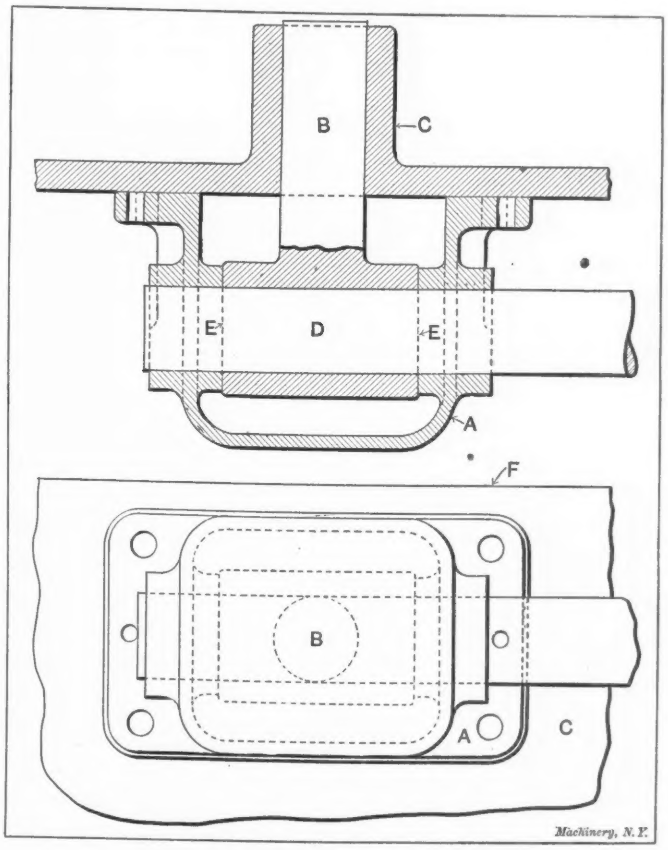

Fig. 3. T-jig for Locating a Bevel Gear Bracket

* For additional information on this and kindred subjects see "Assembling a 48-inch Motor-Driven Planer," in the December, 1909, issue of MACHINERY, and other articles there referred to.

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ets and templets, or in laying off pin holes for cams. It is necessary to provide a number of different sized center punches of this type, as the body of the punch must fit the clearance hole in the work. For obtaining a circle, the diameter of the tap drill, the punch or marker may take the form shown at *B*, while a combination of the two will provide a guard circle.

A flat scriber *C* is very useful for marking a line on a plane surface at right angles to another plane surface when the corner is rounded as shown at *D*. The form of marker illustrated at *E* is for giving permanence to lines intersecting on surfaces at right angles, as for instance, in marking the relative position of a gear on a shaft. At *F* is shown a special marker for laying out a circle, the center of which must coincide with a hole already bored. The body of the marker fits the bored hole and a circle is scribed in the piece to be marked off by rotating the marker when the point is in contact with the work. Two methods of making the scribing point are clearly indicated in the engraving, the one shown at end *G* producing a circle the diameter of the body. In marking off a hole in alignment with a threaded hole, a bushing *H* having a scribing point is made to fit the threaded arbor *I*. This arbor fits the threaded hole, and the bushing is rotated to mark the circle.

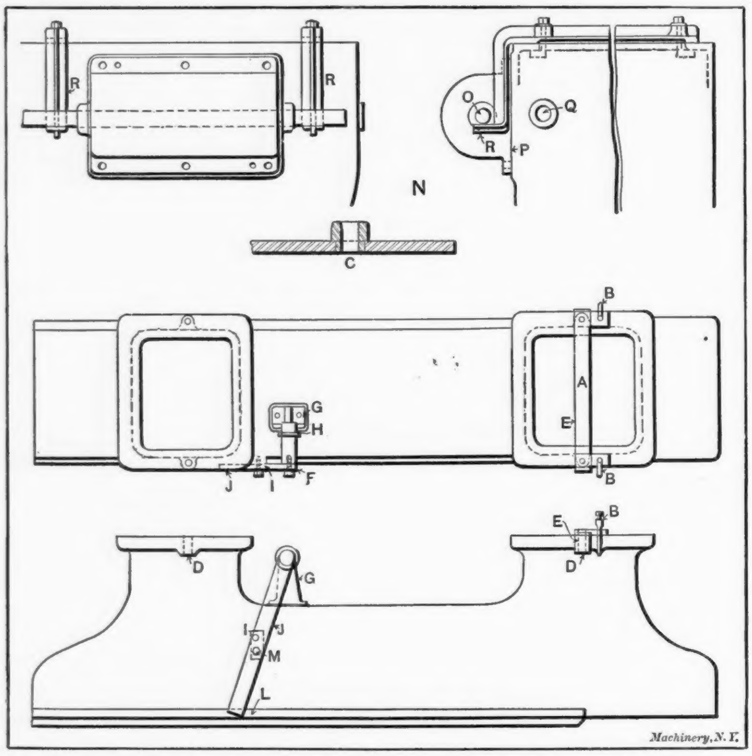


Fig. 4. Special Gages and Templets for Laying-out and Aligning Operations on a Turret Lathe Bed

One of the most convenient and accurate methods of locating gear centers is by the use of links. For drilling or boring operations the link may take the form of a casting provided with hardened steel bushings to guide the cutting tools. Again, a link may be used for cases similar to the one shown in Fig. 2, which illustrates the method of accurately setting a small motor *A* so that its pinion will mesh properly with a gear on shaft *B*. The work is accomplished as follows: With the link *C* and the motor in position as shown, the jack-screw *D* is adjusted until the motor frame just touches the finished seat on the bed. This adjustment is determined by means of tissue paper placed between the motor and bed, after which the bolt holes are marked off on the bed; the special marker *B*, Fig. 1, is used for the purpose. The construction of the link is clearly shown at *E*, Fig. 2; this form, being made of two pieces bolted together, permits of ready application to a shaft supported between bearings, without removing the shaft. Such a case is frequently met with in applying a geared pump to a machine already built. For ordinary cases, however, the link may be made in one casting or forging, as the circumstances require, and provision for clamping may be made by sawing through the ends as far as indicated at *F*.

In Fig. 3 is shown a T-jig for locating a bearing bracket *A* relative to the hole *B* in the main casting *C*. The requirements are that the axes of hole *B* and shaft *D* must intersect, and the faces of hubs *E* must be equidistant from the axis of *B*. It is evident, however, that the T-jig will not take care of the alignment of the shaft *D* with reference to its being parallel with the surface *F*. This may be accomplished by measuring down from surface *F* with either a combination square or surface gage or, in case the adjacent bearing for shaft *D* is already located, bracket *A* will find its own alignment by using this bearing to support the shaft.

The Use of Templets

When a number of pieces are to be made interchangeable without the use of jigs or fixtures, this can be accomplished by the employment of templets for laying out the work. While these devices greatly simplify laying-out and aligning operations, they are not intended for guiding the cutting tools. Templets are particularly well adapted for work where the holes to be laid out lie in the same horizontal plane, and, owing to this condition, the templet usually takes the form of a flat plate of sheet iron, or a wooden piece, having the same general outline as the work to be laid out. Again, many irregular forms are drawn on work from accurately filed templets, after which permanence is given the lines by dotting them with prick-punch marks placed directly on the line.

In making a templet for the first-mentioned class of work, holes are drilled in the templet to conform to the drawing of the piece to be laid out. In use, the templet is laid on the work and is then clamped to it by suitable and convenient means, so that its outline coincides with that of the work. The layout may be transferred to the work by means of a marker as already explained, or, in the case of comparatively large holes, an ordinary scriber is used to mark the circles, and after the templet is removed from the work, the center of each circle is laid out with dividers, permanence being given the lines by a prick punch. Witness circles are often placed on the work to make sure that the original lines were closely followed in drilling, *i. e.*, a circle is drawn in each case 1/32 inch larger in diameter than the one worked to; then, if the hole is correctly drilled, it will be concentric with this circle.

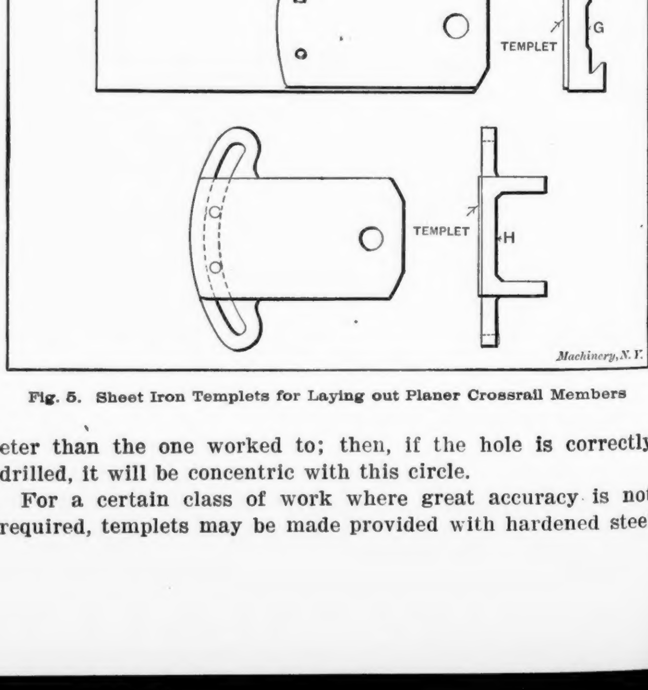


Fig. 5. Sheet Iron Templets for Laying out Planer Crossrail Members

For a certain class of work where great accuracy is not required, templets may be made provided with hardened steel

bushings for guiding the cutting tools independently of the skill of the operator, in which case, however, the templet takes the form of a jig. Owing to the lack of rigidity due to the thin material of which such jigs or templets are constructed, no attempt is made to provide clamping arrangements. The templet may be clamped to the work by means of ordinary C-clamps, or with machinists' clamps. Very frequently, however, it is desirable to provide locating points which may consist of pins extending from one or both sides of the templet, as the case may require, or the locating points may be formed by bending the edges of the metal to a right angle.

The application of a jig such as just described is illustrated in Fig. 4, which shows the method of drilling foundation bolt holes in a turret lathe bed, the holes being drilled from the bottom. As will be seen, the jig or templet *A* consists of three pieces of flat iron riveted together and clamped to the bed by means of clamps *B*. The method of inserting the drill bushings is shown in detail at *C*. To facilitate setting the jig with reference to the bosses *D* on the under side of the bed casting drilling the tap holes in the lathe bed, not shown. Steel lining bushings *E* are provided for the drill bushings. The jig and work are clamped to the drill press table by straps and bolts. The frame consists of four pieces of ash fastened at the corners with glue and wood-screws, the joints being made as shown. Ash is the best wood for the purpose, since, if well seasoned, it is less likely to warp than any other, but where this wood is not available, maple is a good substitute.

A slightly more expensive, but more durable jig, for the same purpose is shown at *F* in the same engraving. This jig is made of flat bar steel riveted together, and is of the same general construction as the wooden one.

Gages for Aligning Operations

A gage may briefly be defined as any standard of comparison; as here used, the term gage will have reference to special devices for aligning work without the employment of ordinary tools such as a combination square, surface gage, etc. Besides greatly facilitating aligning operations, the particular

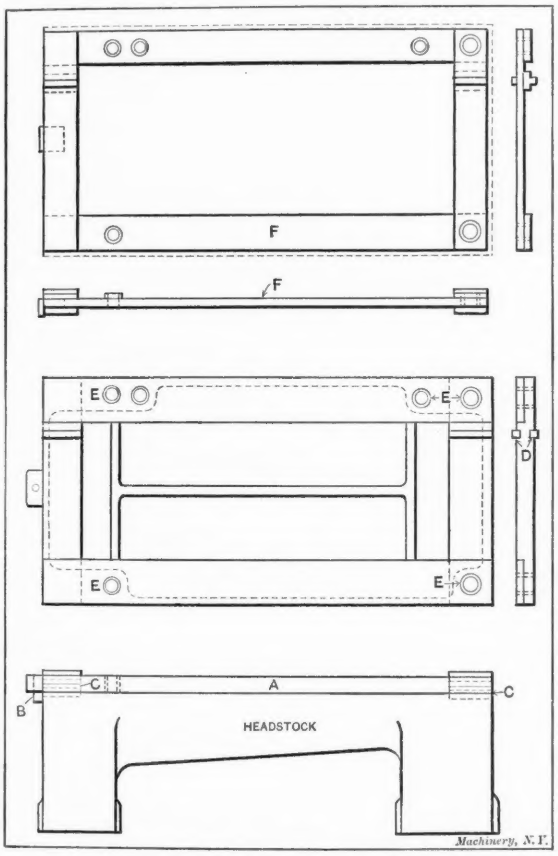


Fig. 6. Application of a Wooden Jig for Drilling a Lathe Headstock. At F is shown a Similar Jig constructed of Flat Bar Steel

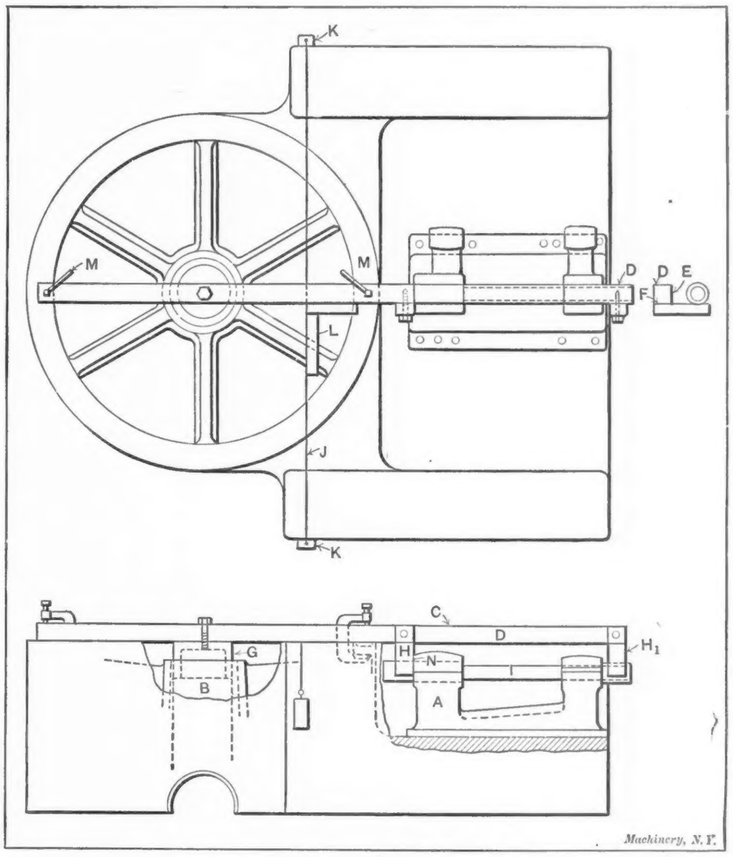


Fig. 7. Gage for Aligning the Driving Shaft Bracket on a Vertical Boring Mill of the Bevel Gear Driven Type

so that the holes when drilled will be concentric with these bosses, jig member *E* is bent to a right angle at each end so as to extend down the casting; the location is determined by matching these ears with the bosses on the bed.

In Fig. 5 is shown the application of sheet iron templets for laying out cross-rail members for large planers. Templet *A* for swivel member *B* is located by the hub *C*, and is lined up to match the end *D*. A separate templet is provided for laying out the swivel clamp *E*; edge *F* of the templet is bent over to form a locating point. But one templet is required for laying out slide *G* and its clapper-box *H*. This is lined up on each member as shown. It is obvious that these templets are more advantageous than cast iron jigs for this class of work, since very large and heavy jigs would be required, and furthermore, no great accuracy is necessary, as the bolt holes have 1/16 inch clearance.

As already stated, a very cheap and serviceable jig for certain classes of work can be constructed of wood. At *A*, Fig. 6, is shown a jig of this character for drilling the clamping bolt holes in an engine lathe headstock—in this case for a 30-inch lathe. The jig is located by pin *B* and keys *C*, the latter fitting a keyway in the headstock; having these keys on both sides of the jig as shown at *D*, it is also used for

advantage of using gages is that the possibility of error due to carelessness in transferring scale measurements is avoided. It is assumed, however, that the gages here shown are intended only for duplicate work; it would not be economy to make gages for aligning only a few pieces.

Turning back to Fig. 4, *F* represents a simple gage for aligning bracket *G* on the bottom of a turret lathe bed. The requirements are that face *H* of the bracket must be a certain definite distance from seat *I* on the bed, but the alignment in a longitudinal direction is non-essential. The gage merely consists of two pieces: a straightedge *J*, planed only on one side and one end, and a gage which is fastened to the end of the straightedge as shown. As surface *L* on the bed lies in the same plane with seat *I*, the straightedge is made long enough to reach this surface, thereby obtaining greater accuracy in the alignment. Bolt hole *M*, already tapped, is utilized for clamping the gage. In aligning the bracket, its face is brought into contact with the gage, and the bracket is then set longitudinally to match its seat on the bed.

Another gage, or more properly speaking, a pair of gages, for aligning a feed-box on the turret lathe bed shown in the lower part of the same engraving, is shown at *N*. The requirement of the present case is simply that the feed-box shaft

hole *O* be located a certain definite distance from the top of the bed; seat *P* on the bed takes care of the center distance from hole *Q*. It is obvious then, that the gage castings *R* should only provide a positive locating surface with reference to the top of the bed; this is accomplished in the manner shown. The location endwise is determined by scale measurement from the end of the bed.

An aligning operation on a vertical boring mill bed, and the gage used, is illustrated in Fig. 7. This boring mill is of the bevel gear driven type, in which the pinion meshing into the table bevel gear is carried on the driving shaft in bracket *A*. The problem of aligning this driving shaft bracket with reference to the spindle hole *B* in the bed, is easily solved by using gage *C*. As will be seen, this gage consists of a bar *D* planed on two sides, *E* and *F*; a bushing *G* fitting the spindle hole; and two gage pieces *H* and H_1. A special arbor *I*, having both its ends ground to the same diameter, fits bracket *A*.

When in use, a line wire *J* is stretched across the bed by means of weights *K*. This wire lies in a small groove or mark planed in the bed for the double purpose of squaring the gage and setting the housings. Square *L* is used in setting the gage before it is clamped by means of clamps *M*, so that when the bed members are assembled, the driving shaft will be approximately square with the housing faces. With the gage in this position, bracket *A* is set so that its arbor just touches the gage blocks *H* and H_1. The location with reference to the distance from spindle hole *B* in the bed is determined by simply bringing the hub face *N* on bracket *A* into contact with the side of gage block *H*. After the operation of marking off the tap holes in the bed is accomplished, and the holes are drilled and tapped, bracket *A* is reset in the same manner and clamped by its bolts, for drilling and reaming the dowel pin holes.

* * *

A few years ago mahogany was regarded as a very precious wood and was employed only for the interior finish of the finest houses and in the manufacture of high-priced furniture. During the past few years, however, there has been a wonderful development in mahogany importation and use. The total quantity of mahogany imported in 1908 was nearly forty-two million board feet. It is one of the most valuable woods known for other than decorative purposes. As a pattern material it is unsurpassed, being strong, light and not as much affected by rough usage as pine. It takes glue remarkably well and is also superior to pine in that it is not affected as much by dampness.

DERIVATION OF BEVEL GEAR FORMULAS*†

RALPH E. FLANDERS‡

In the present article are given the derivations of the formulas used for calculating the dimensions of bevel gearing for all conditions of shaft angles and types of gears, including bevel gears with shafts at right angles, miter gearing, bevel gears with shafts at acute or obtuse angles, crown gears, and internal bevel gears.

In Fig. 1 is shown an axial section of a bevel gear, the pitch lines showing the location of the imaginary pitch cone. The pitch cone angle is the angle which the pitch line makes with the axis of the gear. The pitch diameter is measured across the gear drawing at the point where the pitch lines intersect the outer edge of the teeth. In speaking of the pitch of a bevel gear we always mean the pitch of the larger or outer ends of the teeth. Diametral and circular pitch have the same meaning as in the case of spur gears, the diametral pitch being the number of teeth per inch of the pitch diameter, while the circular pitch is the distance from the center of one tooth to the center of the next, measured along the pitch diameter at the back faces of the teeth. The addendum is the height of the tooth above the pitch line at the large end. The dedendum (the depth of the tooth space below the pitch line), and the whole depth of the tooth are also measured at the large end.

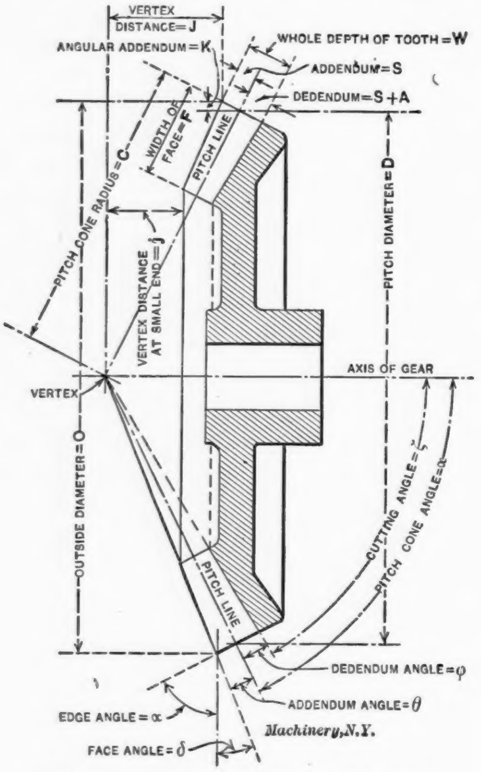


Fig. 1. Dimensions, Definitions and Reference Letters for Ordinary Bevel Gear

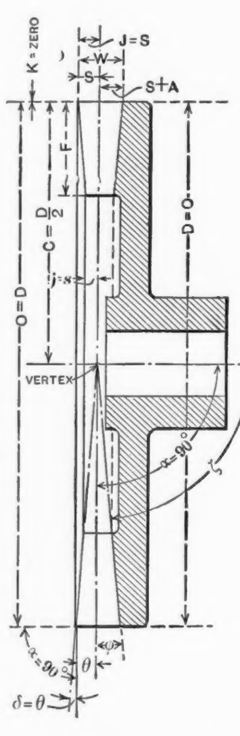


Fig. 2. Dimensions for Crown Gear

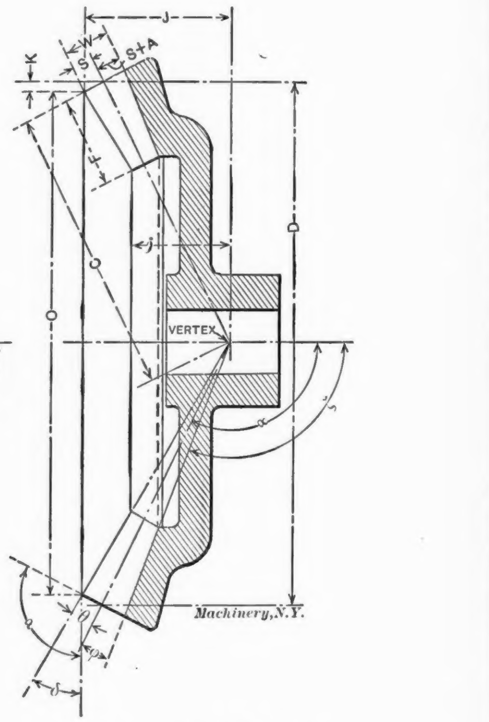


Fig. 3. Dimensions for Internal Bevel Gear

The pitch cone radius is the distance measured on the pitch line from the vertex of the pitch cone to the outer edge of the teeth. The width of the face of the teeth, as shown in Fig. 1, is measured on a line parallel to the pitch line. The addendum, whole depth and thickness of the teeth at the

* With Data Sheet Supplement.

† The following articles dealing with the subject of bevel gearing have previously been published in MACHINERY: Cutting Bevel Gears with Rotary Cutters, January, 1897; Bevel Gear Formula, January, 1898; Cutting Bevel Gears with Correct Teeth, June, 1898; Cutting Bevel Gears, June, 1898; Chamfering Bevel Gears, July, 1902; Bevel Gear Chart, September, 1905; To Calculate the Center Angles of a Pair of Bevel Gears having their Axes at other than Right Angles, June, 1906; Strength of Gears, December, 1906, engineering edition; Bevel Gear Diagrams, May, 1907, engineering edition; Bevel Gear Formulas, May, 1907, engineering edition; Cutting Bevel Gears with a Rotary Cutter, October, 1907; A Bevel Gear Gage, January, 1909; A Bevel Gear Problem, April, 1909. Cutting Bevel Gear Teeth—A New Method of Obtaining the Set-over, December, 1909, engineering edition; Accurate Setting of the Bevel Gear Cutter, December, 1909, engineering edition. See also MACHINERY'S Data Sheet No. 36, September, 1904, Proportions of Bevel Gears; No. 37, October, 1904, Dimensions of Miter Gears; No. 64, December, 1906, Strength of Bevel Gears; No. 69, May, 1907, Bevel Gear Formulas and Diagrams; No. 102, Extra Data Sheet, October, 1908, Table for Determining the Outside Diameter of Bevel Gears; MACHINERY'S Reference Series No. 37, Bevel Gearing.

‡ Associate Editor of MACHINERY.

small or inner end may be derived from the corresponding dimensions at the outer end, by calculations depending on the ratio of width of face to the pitch cone radius. (See s, w and t in Fig. 4.)

The addendum angle is the angle between the top of the tooth and the pitch line. The dedendum angle is the angle between the bottom of the tooth space and the pitch line. The face angle is the angle between the top of the tooth and a perpendicular to the axis of the gear. The edge angle (which equals the pitch cone angle) is the angle between the outer edge and the perpendicular to the axis of the gear. The latter two angles are measured from the perpendicular instead of from the axis for the convenience of the workman in making measurements with the protractor when turning the blanks. The cutting angle is the angle between the bottom of the tooth space and the axis of the gear.

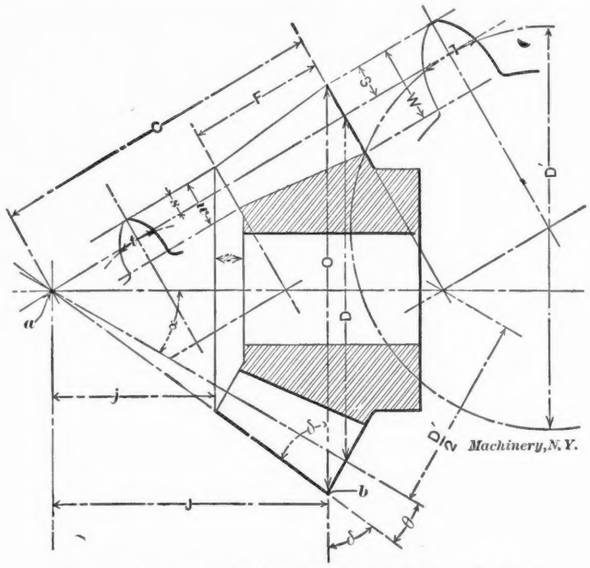


Fig. 4. Diagram Explaining Certain Calculations Relating to Bevel Gears

The angular addendum is the height of tooth at the large end above the pitch diameter, measured in a direction perpendicular to the axis of the gear. The outside diameter is measured over the corners of the teeth at the large end. The vertex distance is the distance measured in the direction of the axis of the gear from the corner of the teeth at the large end to the vertex of the pitch cone. The vertex distance at the small end of the tooth is similarly measured.

The shape of the teeth of a bevel gear may be considered as being the same as for teeth in a spur gear of the same pitch and style of tooth, having a radius equal to the distance from the pitch line at the back edge of the tooth to the axis of the gear, measured in a direction perpendicular to the pitch line. This distance is dimensioned $\frac{D'}{2}$ in Fig. 4. The number of teeth which such a spur gear would have, as determined by diameter D' thus obtained, may be called the "number of teeth in equivalent spur gear," and is used in selecting the cutter for forming the teeth of bevel gears by the formed cutter process.

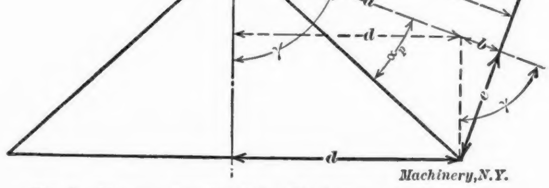


Fig. 5. Diagram for Obtaining Pitch Cone Angle of Acute Angle Gearing

In two special forms of gears, the crown gear, Fig. 2, and the internal bevel gear, Fig. 3, the same dimensions and definitions apply as in regular bevel gears, though in a modified form in some cases. In the crown gear, for instance, the pitch diameter and the outside diameter are the same, and the pitch cone radius is equal to one-half the pitch diameter. The addendum angle and the face angle are also the same. The angular addendum becomes zero, and the vertex distance is equal to the addendum. The number of teeth in the equivalent spur gear becomes infinite, or in other words, the teeth are shaped like those of a rack.

When the pitch cone angle is greater than 90 degrees, so that the gear becomes an internal bevel gear, as in Fig. 3, the outside diameter (or edge diameter as it is better called in the case of internal gears) becomes less than the pitch diameter. Otherwise the conditions are the same, although many of the dimensions are reversed in direction.

Rules and formulas for calculating the dimensions of bevel gears are given in the accompanying Data Sheet Supplement. The following reference letters are used:

N = number of teeth,
P = diametral pitch,
P' = circular pitch,
π = 3.1416,
α = pitch cone angle and edge angle,
γ = center angle (angle between axes of two meshing gears),
D = pitch diameter,
S = addendum,
$S + A$ = dedendum (A = clearance),
W = whole depth of tooth space,
T = thickness of tooth at pitch line,
C = pitch cone radius,
F = width of face,
s = addendum at small end of tooth,
t = thickness of tooth at pitch line at small end,
θ = addendum angle,
ϕ = dedendum angle,
δ = face angle,
ζ = cutting angle,
K = angular addendum,

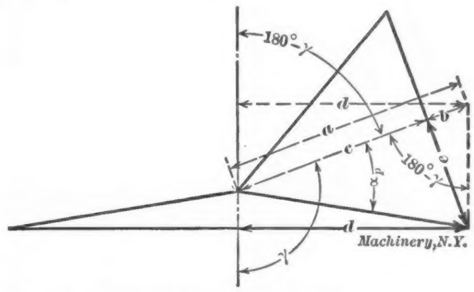


Fig. 6. Diagram for Obtaining Pitch Cone Angle of Obtuse Angle Gearing

O = outside diameter (edge diameter for internal gears),
J = vertex distance,
j = vertex distance at small end,
N' = number of teeth in equivalent spur gear.

Sub $_p$ refers to dimensions applying to pinion (α_p, N_p, etc.).

Sub $_g$ refers to dimensions applying to gear (α_g, N_g, etc.).

It will be noted that directions for the use of these rules are given for each of the six cases of right angle bevel gearing, miter bevel gearing, acute angle and obtuse angle bevel gearing, and crown and internal bevel gears.

Rules and Formulas for Bevel Gear Calculations

The derivation of most of these formulas is evident on inspection of Figs. 1 to 4, inclusive, for anyone who has a knowledge of elementary trigonometry. It is not necessary to know how they were derived to use them, however, as all that is needed is the ability to read a table of sines and tangents.

Formulas 5, 6, 7 and 8 are the same as for Brown & Sharpe standard gears. The dimensions at the small end of the tooth given by Formulas 10, 11 and 19 obviously are to the corresponding dimensions at the large end, as the distance from the small end of the tooth to the vertex of the pitch cone is to the pitch cone radius. This relation is expressed by these formulas. The derivation of Formula 20 may be understood by reference to Fig. 4:

$$D' = \frac{D}{\cos\alpha} = \frac{N}{P \times \cos\alpha}, \text{ also } D' = \frac{N'}{P}$$

$$\text{therefore } \frac{N'}{P} = \frac{N}{P \times \cos\alpha}, \text{ or } N' = \frac{N}{\cos\alpha}$$

Formula 21, for checking the calculations, will also be understood from Fig. 4, where it will be seen that

$$O = 2\,ab \times \cos\delta, \text{ also that } ab = \frac{C}{\cos\theta}$$

$$\text{therefore } O = \frac{2\,C \times \cos\delta}{\cos\theta}$$

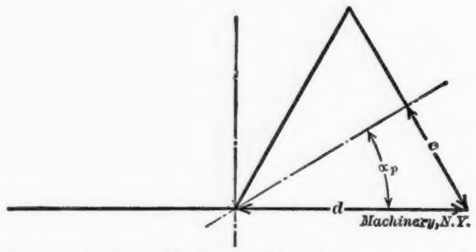


Fig. 7. Diagram for Obtaining Pitch Cone Angle of Pinion to mesh with Crown Gear

Formulas 22 to 27 inclusive are simply the corresponding Formulas 1, 9, 14, 15, 16 and 20 when $\alpha = 45$ degrees.

Formula 28 is derived as shown in Fig. 5.

$$c = \frac{e}{\tan\alpha_p}, \text{ also } c = a + b = \frac{d}{\sin\gamma} + \frac{e}{\tan\gamma}$$

$$\text{therefore, } \frac{e}{\tan\alpha_p} = \frac{d}{\sin\gamma} + \frac{e}{\tan\gamma}$$

$$\text{Solving for } \tan\alpha_p \text{, we have: } \tan\alpha_p = \frac{e\,(\sin\gamma \times \tan\gamma)}{d\tan\gamma + e\sin\gamma}$$

Dividing both numerator and denominator by $e\tan\gamma$, we have:

$$\tan\alpha_p = \frac{\sin\gamma}{\dfrac{d}{e} + \dfrac{\sin\gamma}{\tan\gamma}}$$

$$\text{Since } d = \frac{N_g}{2P} \text{ and } e = \frac{N_p}{2P} \text{, and since } \frac{\sin}{\tan} = \cos \text{, we have:}$$

$$\tan\alpha_p = \frac{\sin\gamma}{\dfrac{N_g}{N_p} + \cos\gamma}$$

Formula 29 is derived by the same process for the other gear. Formula 31 (and likewise 33) is derived from Fig. 6, using the following fundamental equation:

$$\frac{e}{\tan\alpha_p} = \frac{d}{\sin(180° - \gamma)} - \frac{e}{\tan(180° - \gamma)}$$

When solved for $\tan\alpha_p$, this gives formula 31.

Rule 32, of course, simply expresses the operation of finding out whether the pitch cone angle of the gear is less, equal to, or greater than 90 degrees. The derivation of Formula 34 is shown in Fig. 7:

$$\sin\alpha_p = \frac{e}{d} = \frac{N_p}{N_g}$$

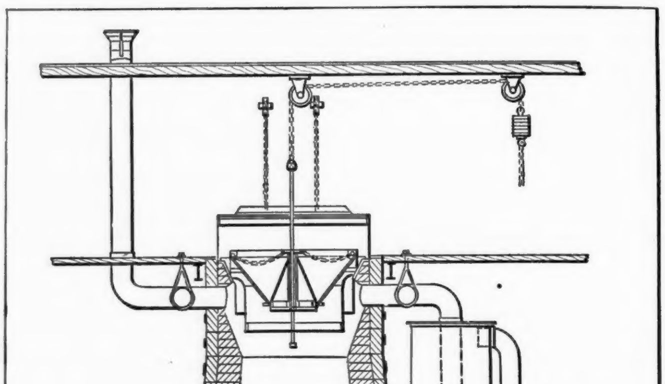
Since in a crown gear the dimension $\frac{D'}{2}$ in Fig. 4 is to be measured parallel to the axis, and will therefore be of infinite length, the form of the teeth will correspond to those of a spur gear having a radius of infinite length, that is to say, to a rack. This accounts for Formula 38.

Formulas 39, 40, 42 and 44 are simply the corresponding Formulas 33, 9, 16 and 20 changed to avoid the use of negative cosines, etc., which occur with angles greater than 90 degrees. These negative functions might possibly confuse readers whose knowledge of trigonometry is elementary. The other formulas for internal gears are readily comprehensible from an inspection of Fig. 3.

ELECTRIC SMELTING OF IRON AND STEEL*

At Gysinge, in Sweden, in one of the works belonging to the Stora Kopparbergs Bergslags Aktiebolag, a furnace as shown in the accompanying engraving is installed. This furnace is similar to a common blast furnace, but is provided with three electrodes fed by three-phase alternating current at about 40 volts, 60 cycles and 9,500 amperes, 674 H. P. The electrodes take the place of the tuyeres. This furnace has been running for 1,903 hours and 28 tons of iron, containing from 0.95 to 3.09 per cent of carbon has been produced. The temperature of the escaping gases from the furnaces is generally very low, and they contain on an average about 22 per cent of carbon dioxide. The gases contain practically no nitrogen, but considerable steam from the water in the ore, lime, coke or charcoal is present. No air whatever is used in the process, and the gases are produced from the carbon in the charcoal and coke, and the oxygen in the ores ($FeO + C = Fe + CO$). Either charcoal or coke may be used, but the consumption of fuel will be practically the same in either case.

The line engraving shows a vertical section through the furnace which consists of a lower portion or smelting chamber, corresponding to the hearth of a blast furnace, and a top section or blast. The latter is supported on columns, which prevent any weight from bearing on the arch of the smelting



Electric Blast Furnace built at Gysinge, Sweden

chamber. The latter is so proportioned as to provide a considerable amount of free space between the charge and the arched roof through which the carbon electrodes project into the charge. The brickwork is thus protected against any very high temperature, and remains a non-conductor of electricity. This is an important feature of this furnace, since experiments have shown that if the electrodes enter the chamber at the point where the charge touches the walls, a very high temperature is generated at this point; the brickwork is destroyed and becomes a conductor of electricity, giving rise to a more or less complete short-circuit. The charge is made up of ore, lime, coke and charcoal. The ore and fuel are crushed to a suitable size, and are fed into the top of the furnace through the bell hopper in the usual way.

* Abstract of paper by Mr. E. J. Ljungberg, of Falun, Sweden, read before the Iron and Steel Institute of Great Britain.

THREAD ROLLING*

J. F. SPRINGER†

Of the several methods used for producing threads on screws, the one least understood or known by mechanics in general is the process of thread rolling. When threads are produced by means of this process, the blank, which is held in a machine made for this purpose, is rolled between two dies or blocks, provided on their faces with grooves of the right pitch, form and angle of lead, as shown in Fig. 1. The thread

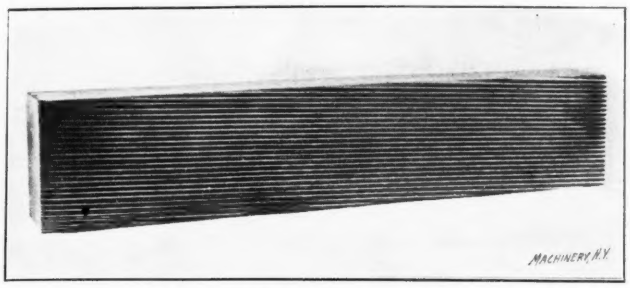


Fig. 1. A Thread Rolling Die for Rolling United States Standard Threads

is formed by the displacement of the metal, some part of which is forced up to form the top of the thread. The finished screw, therefore, is larger in diameter than the blank.

That it is possible to form or roll a perfect thread by means of straight grooves or threads cut into a flat block or die, will be understood by imagining the thread helix as unrolled upon a flat surface. In Fig. 2, for instance, the line *AB* indicates

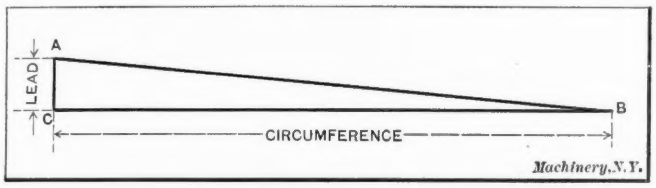


Fig. 2. Diagram for Determining Angle of Threads in Thread Rolling Dies

the helix of a thread thus developed on a flat surface; the line *AC* is the lead of the thread, and the line *BC* is the developed circumference of the screw. It is necessary, of course, that the angle of the thread cut on the flat thread rolling die be the same as the helix angle of the thread, which, in turn, is the same as the angle *ABC* in Fig. 2. The tangent of this angle, of course, equals

$$\frac{AC}{BC} = \frac{\text{Lead}}{\text{Circumference}} = \frac{\text{Lead}}{\text{Diameter} \times 3.1416}$$

These general remarks indicate the main principles involved in the process of thread rolling. In the following some of the elementary matters to be considered in this connection will be treated.

Methods Used for Thread Rolling

There have been a number of methods proposed for carrying out the mechanical operation of rolling threads. As far back as 1851 a machine was built for this purpose. In this machine the blank was rolled between dies or blocks with their faces vertical, one of the dies having a reciprocating motion in a direction at right angles to the axis of the blank. This fundamental idea of construction has been retained in some of the most modern thread rolling machines. Flat dies with their faces placed horizontally have also been used, but there is, as far as the writer knows, no machine of this type now on the market. In another type of thread rolling machine a cylindrical die rotating on its axis and provided with thread grooves on the outside, is set horizontally within a hollow cylindrical die provided with threads on the inside. This thread rolling machine, known as the rotary machine, is at the present time on the market. It has the merit of continuity of production; when one bolt has just been rolled, another is fed in immediately without the necessity of the reversal of the movement which in reciprocating machines causes a period of idleness. The disadvantage of the lost time in reciprocating machines, however, is partially removed by introducing a return movement which is more rapid than the advance; but the continuity of action of the rotary thread roller is, no doubt, an item of importance. A single revolution of the convex die produces, in fact, four bolts.

Automatic Feed for Screw Blanks

There are, however, other things to consider besides continuity of action. An important question is the feeding of the blanks, and the machine having flat dies of the type shown in Fig. 1, set with their faces vertical, lends itself best to automatic methods of supplying the blanks. In such feeding mechanisms the greatest problem probably is that of getting the blanks into the required position for the operation to be performed upon them. A device for this purpose is illustrated in Fig. 3. The blanks for the screws are placed in a hopper *A* of generous size located at the top of the machine. There is a long slot in the bottom of the hopper through which a flat plate *B*, called the center-board, is vertically reciprocated. This center-board has a vertical slot whose width is just a trifle in excess of the diameter of the body of the blank. When this slotted center-board rises through the slot in the bottom of the hopper—the motion being actuated by a cam and gearing as shown—one or more blanks are likely to drop, under the influence of their weight, into the slot in the plate. These blanks then hang suspended by their heads as shown. Sometimes, however, the center-board will rise through the mass of blanks in the hopper without any blank being properly located to come into the required position; but the mass of blanks will be disturbed and the next time the board rises some blanks may be caught in the manner necessary for feeding to the machine, and sooner or later one or more bolts will be suspended by their heads. To get a sufficient number to supply the machine, all that is necessary is to proportion the mechanism properly and to operate it at a suitable rate of speed.

Sometimes the blanks will be picked up crosswise or get into other unfavorable positions across the edge of the slotted center-board. An auxiliary device may then be employed to throw off such blanks. In Fig. 3 several blanks are shown

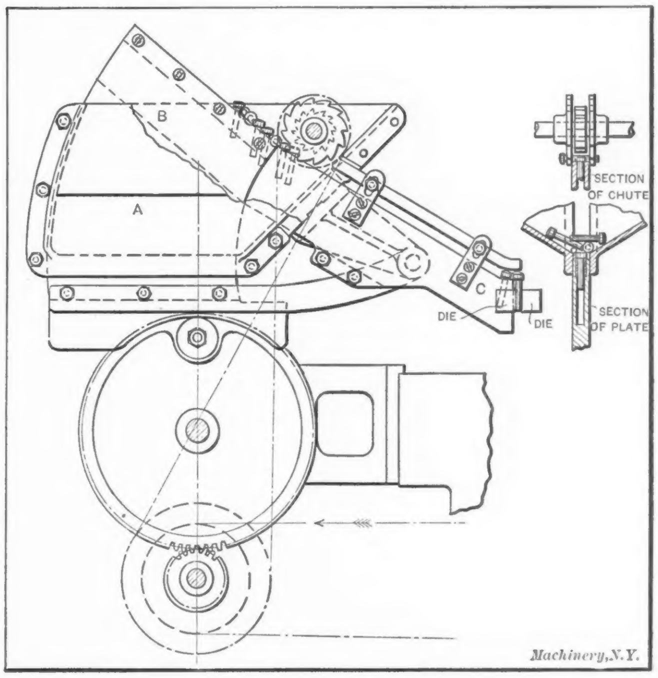


Fig. 3. Automatic Feeding or Hopper Mechanism for Screw Blanks in Thread Rolling Machines

in the proper position in the slot and two others are already delivered to the fixed portion *C* of the chute, while a number are in unsuitable positions for feeding. As the blanks in or on the center-board move onward to the fixed part of the chute, they pass under and between a rotating system of three toothed wheels of the ratchet-wheel type. The outside wheels pass close to the outer edges of the board, while the inner wheel passes close above the heads of the blanks which are properly caught. This is indicated in the upper sectional

* See MACHINERY, November, 1909, engineering edition: Calculating the Size of Blank for Rolling Screw Threads.

† Address: 625 W. 135th St., New York City.

view to the right in Fig. 3. If a blank is in the correct position in the chute it will not be disturbed by the wheels, but if not, it will be thrown off. The lower sectional view to the right shows a typical situation of the blanks when the center-plate rises through the slot at the bottom of the hopper.

It will be seen in Fig. 3 that as the blanks pass down the inclined chute they are prevented from subsequent displacement by an adjustable guide or keeper passing over their heads. At the end of the chute the direction of the blanks becomes vertical and they are then caught between the dies and the thread rolled. Of course, all thread rolling machines

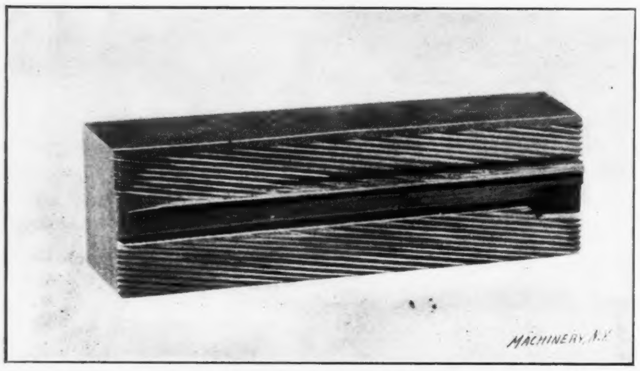


Fig. 4. A Reversible Thread Rolling Die for Wood-screws

are not fed with automatic hoppers of this type. Conditions decide when and when not to employ devices of this kind.

The Thread Rolling Process

One of the thread-rolling dies is stationary while the other has a reciprocating movement. Both dies are exactly the same otherwise except for length. The thread-rolling die shown in Fig. 1 is for a right-hand thread, the grooves inclining downward toward the right. For a left-hand thread, the threads on the dies incline downward toward the left. In Fig. 4 is shown a reversible die. In this die when the upper portion is worn down the lower portion may be brought into service by reversing the die. This die is for rolling wood-screw threads. On account of the gimlet point required, the surface of the die is not flat. In rolling screw threads using one stationary and one reciprocating die, the working stroke of the moving die must be at least twice the length of the fixed

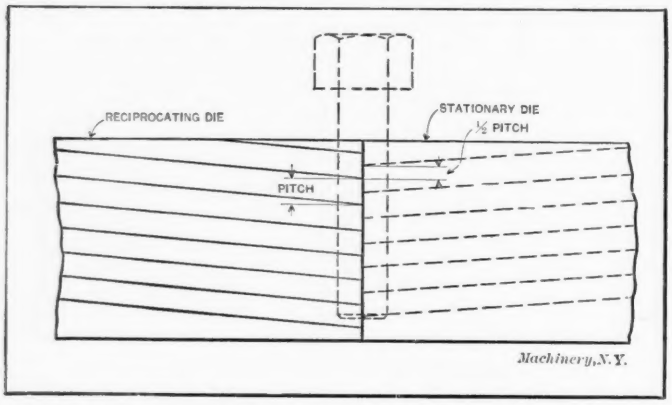


Fig. 5. Diagrammatical View showing the Relative Positions of the Thread Rolling Dies when starting to roll a Thread

die, otherwise the screw blank would not be rolled over the full face of the fixed die, but would be carried back at the return of the movable die. While a good thread might be rolled that way, it would obviously be impracticable to have the screw blank return, if for no other reason than because it would interfere with the blank just fed into the dies.

When calculating the angle of the threads on the die face, the circumference of the die blank should be taken as the length of the side *BC* in Fig. 2. For example, suppose that we wish to roll an ordinary V-thread having a finished diameter of ¾ inch, and 10 threads per inch. The diameter of the blank is found by Formula (11), on page 181 of MACHINERY, engineering edition, November, 1909. This diameter is 0.689 inch, and the circumference of the blank, consequently, 2.165 inches. The screw having 10 threads per inch, the lead is 0.100 inch and hence the tangent of the angle of the thread on the die face $= \frac{0.100}{2.165} = 0.046$, giving an angle for the thread of 2 degrees 40 minutes.

A little thought will easily convince one that when starting to roll the thread it is necessary that the grooves in one die be in a given relation to the grooves in the other. The two dies work on the screw on parts separated one-half turn, and as one-half turn of the screw corresponds to one-half of the pitch, the ridges and grooves of points exactly opposite each other must be one-half of the pitch above or below the corresponding ridges and grooves in the other die. (See Fig. 5.) In rolling threads this relative adjustment must be secured, otherwise the thread rolled by one die would not coincide with that formed by the other. It is, therefore, necessary to have vertical adjustment in the slides in which the dies are mounted.

It will be understood from what has been said that not only is it important that the two die faces be adjusted exactly in relation to each other, but also that the blank be started exactly at the time when points on opposite faces of the dies are in the correct relation to each other. It is, therefore,

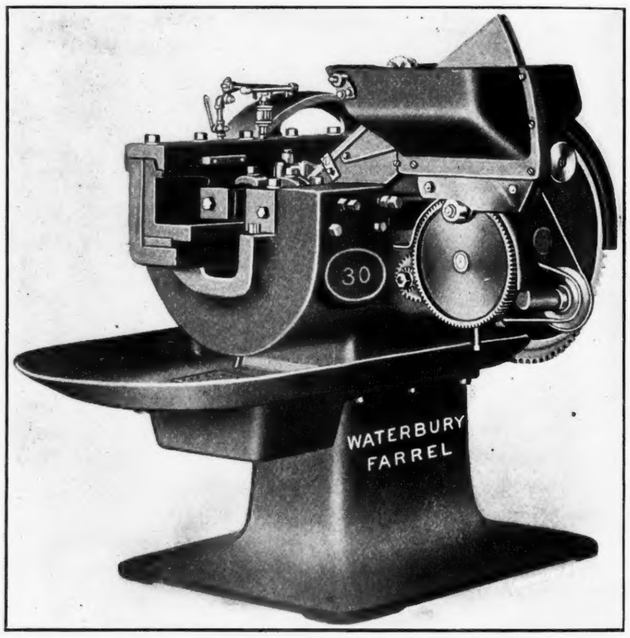


Fig. 6. A Waterbury Farrel Foundry & Machine Co.'s Thread Rolling Machine with Automatic Hopper Mechanism

necessary to have means of adjustment for timing the start of the operation of rolling the blank. For this purpose a starting rod is used. The blank stands with its head pointing upward at the proper level and close to the right-hand edge of the fixed die. The die is cut away at this point so that as long as the blank remains there, no work will be accomplished by the movement of the reciprocating die. The starting rod then forces the blank between the dies at the precise moment when the threads are in the proper relation to each other. The starting rod is usually referred to as the "starter." It is, of course, important that the blank pass through in a perfectly upright position. If it is started vertically there is ordinarily no difficulty in maintaining it so. At the moment of starting, the starter forces it against the vertical edge of the fixed die, which is sufficient for usual requirements. If the blank is very long, it may need support at its upper end; this support in most cases may be given by the hand of the operator.

At the first part of the stroke the bolt is only partially penetrated by the threads in the dies. The dies, therefore, are not mounted exactly parallel, but so that they are further apart from each other at the point where the rolling process commences. When the bolt has rolled all the way through to the left-hand edge of the fixed die the operation is complete and the movable die begins to return. It has been found desirable to provide a means of preventing the bolt from getting

caught and carried back between the dies. Gravity alone cannot be depended upon because of the possibility of the thread on the screw clinging to the moving die. One method for throwing off the work is by the use of a flat spring. One arm of a rather obtuse V protrudes over the upper edge of the movable die. When the bolt comes along its head or upper part strikes this arm of the V, forcing it back; when the work has passed, the arm returns to its normal position, so that it prevents the work from following the die back. The spring

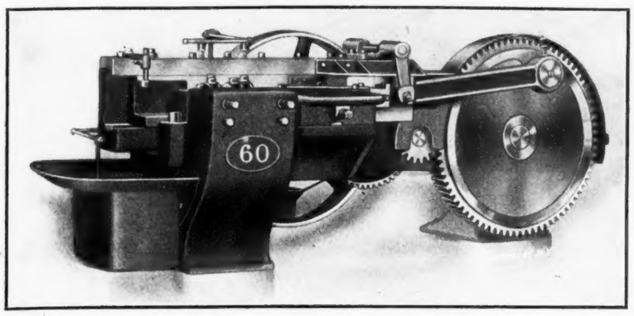


Fig. 7. Large Thread Rolling Machine

will not be pressed back on the return stroke, as the work is not held very firmly to the die.

Advantages of Thread Rolling

As already mentioned, the rolling of threads increases the outside diameter; thus in the example previously given, a blank 0.689 inch in diameter produces a thread of 0.750 inch in diameter, or an increase of 0.061 inch—over 8 per cent. It will be seen, then, that if the diameter of that part of the bolt which is not threaded and the threaded portion are desired to be the same, blanks must be used having a smaller

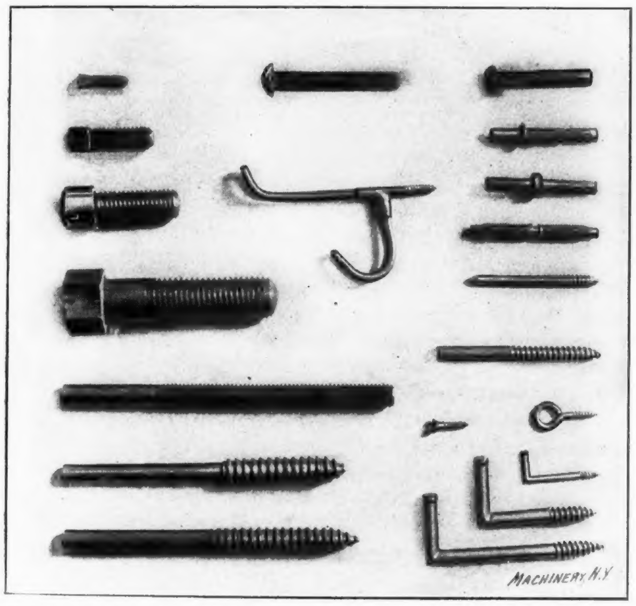


Fig. 8. Examples of Work performed in Thread Rolling Machines

diameter where the thread is to be formed.

The fact that thread rolling is accomplished without waste is perhaps a consideration worth taking into account.* Suppose that we are threading ¾-inch bolts, the threaded part being 4 inches long. When cutting the threads in a lathe or with dies we use full size stock, but when rolling them we can use stock 0.689 inch in diameter. The saving is expressed by the formula:

$$S = \frac{\pi}{4}(G^2 - g^2)\, l$$

in which G is the diameter of the finished thread, g the diameter of the blank, and l the length of the thread. For the example above, we find:

$$S = 0.7854\ (0.750^2 - 0.689^2) \times 4 = 0.276 \text{ cubic inch.}$$

For 10,000 bolts we would have a saving of 2,760 cubic inches, or about 770 pounds of steel.

* The bolts for holding together the cast-iron sections of the Hudson tunnel tube are all provided with rolled thread.

Quite aside from the question of economy of material is that of the quality of the product. A bolt or screw whose threads have been rolled may not be suited to applications where microscopic accuracy of the threads is essential; no one would think of using a rolled thread for a micrometer screw. The strength of the thread, however, appears to be fully that of cut threads, although the writer is not aware of any extended comparative tests having been made between cut and rolled threads. It seems reasonable to expect even greater strength from these threads for the reason that the rolling process, executed on cold metal, may be expected to impart firmness to the thread and adjacent parts.

One of the greatest advantages of the manufacture of bolts and screws by the rolling process is the rapidity with which the work can be carried out. The smallest machine manufactured by the Waterbury Farrel Foundry & Machine Company, for instance, having a capacity of stock up to 3/16 inch in diameter, will roll screws at the rate of one every 4/5 of a second. If the thread is short, this speed, it is claimed, can be increased. The largest machine, having a maximum capacity of blanks 1½ inch in diameter, is said to be capable of rolling threads at a rate of one every three seconds. In Fig. 6 is shown a medium-sized thread rolling machine provided with the automatic feeding device illustrated in Fig. 3. As shown in the half-tone, the center-plate is at the highest point. The toothed wheel arrangement for removing blanks improperly caught by the center-plate is barely visible over the edge of the hopper. The fixed die is on the side toward the observer, the movable die being mounted in a slide having guides at top and bottom as indicated. In Fig. 7 is shown a larger machine which is not provided with an automatic feeder.

In Fig. 8 are shown a number of screws and other pieces of work having threads produced by rolling. Among these samples is a wood-screw with tapering thread and gimlet point. In other samples the thread is straight until near the end, where a gimlet form is produced. Attention may be directed to the longitudinal grooves on two of the pieces at the top of the illustration. While these are not threads in the ordinary sense, although they might be regarded as groups of multiple threads with an infinite lead, they may be readily formed by a rolling operation. Another sample shows a thread with a very steep lead. Pieces with a threaded portion at each end, one right-hand and the other left-hand, are also shown. That it is practicable to thread very close up to the head may be seen from some of the samples to the left.

* * *

THE "NEW MECHANICS"

In an address before the French Association for the Advancement of Science, Mons. Henrie Poincaré recently pointed out the contrast between the so called "new mechanics" and the old mechanics based upon Newton's laws of motion. The conceptions of the new science of motion are not easily presented in a popular form, because of their entire novelty. In a word, the modern idea is that a constant force acting upon a moving body does not impart equal increments of velocity in each successive second, but that the accelerative effect decreases as the velocity of the body becomes greater, and finally reaches a limit which it cannot pass. This limit is the velocity of light. In other words, the inertia of matter increases with its velocity of translation, and becomes infinite when the velocity is equal to that of light. Another form of statement is that the mass of a material body increases with its velocity of movement, and that there can be no motion swifter than that of light, that is, about 186,330 miles per second.—*Youth's Companion.*

* * *

CORRECTION

In the articles "Machining Cylinders and Pistons for Automobile Engines" and "Automobile Factory Practice," January number, engineering edition, it was stated that in the Nordyke & Marmon shops pistons are lapped in dummy cylinders, using oil and emery. This is an error as regards the abrasive. Powdered glass is used instead of emery on account of the well-known tendency of emery to embed in cast iron and cause destructive wear in use.

MACHINE SHOP PRACTICE*

THE VERNIER SCALE–ITS PRINCIPLE AND METHOD OF READING

Every machinist knows how confusing it is to take measurements with a scale that is graduated in hundredths or even sixty-fourths of an inch, owing to the multiplicity of lines. If it were possible to graduate a scale to thousandths, that is, so that every inch would be divided into a thousand equal parts, it would, of course, be useless, owing to the extreme

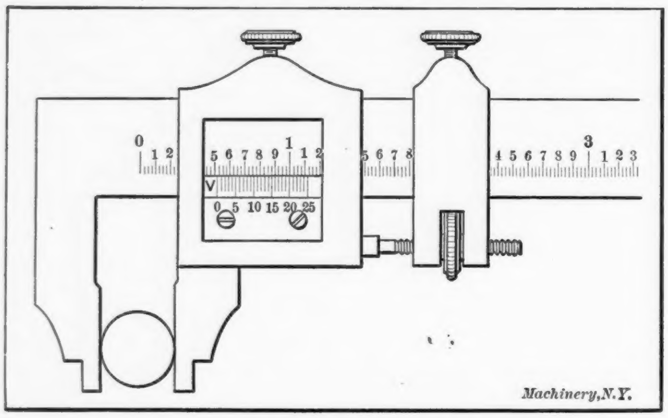
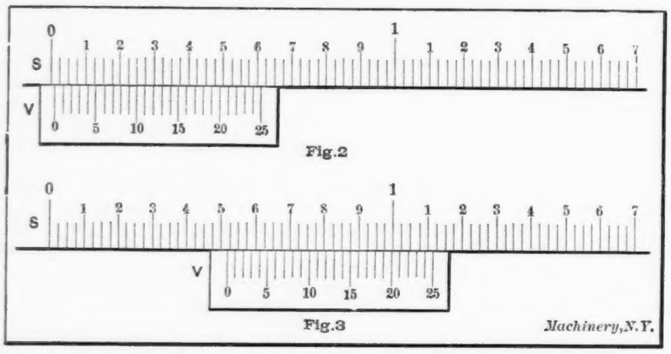


Fig. 1. Caliper Square with Vernier reading to Thousandths

fineness of the lines and the minute distances between them. Such fine divisions on a scale are not, however, necessary, for by means of a special auxiliary scale called a vernier (after its inventor), graduations which are comparatively large can be divided so that fine measurements may be taken. For example, the true or regular scale of the caliper-square shown in Fig. 1, is graduated in fortieths of an inch; but by means of the vernier scale *V*, which is attached to the sliding head of the instrument, measurements within one-thousandths of an inch may be taken. In other words, the vernier, in this case, makes it possible to divide each fortieth of an inch on the true scale into twenty-five parts. The vernier may be defined, then, as an auxiliary scale that is attached to caliper



Figs. 2 and 3. Scales with Verniers set to Different Positions

squares, protractors, etc., for obtaining fractional parts of the sub-divisions of the true scale of the instrument.

By referring to the enlarged scales shown in Figs. 2 and 3, the principle of the vernier can be more easily understood. Here each inch of the true scale *S* is divided into ten parts, and each tenth into four parts, so that the finest divisions are fortieths of an inch. The vernier scale *V* has twenty-five divisions, and its total length is equal to twenty-four divisions on the true scale, or 24/40 of an inch; therefore, each division on the vernier equals 1/25 of 24/40 or 24/1000 inch. Now, as 1/40 equals 25/1000, we see that the vernier divisions are 1/1000 inch shorter than those on the true scale. If, then, the zero marks of both scales were exactly in line, the two first lines to the right would be 1/1000 inch apart; the next two 2/1000; etc. It is evident then that if the vernier be moved to the right until, say, the tenth line from the zero mark exactly coincides with one on the true scale, as shown in Fig. 2, the movement will be equal to 0.010 inch, since this line was 0.010 inch to the left of the mark with which it now coincides, when the zero lines of both scales were together. Similarly, if the fifteenth line were exactly opposite a line on the true scale the movement of the vernier would be equal to 0.015, etc.; so we see that the number of thousandths that the vernier zero has moved past a graduation on the true scale, is determined simply by counting the number of spaces between the zero of the vernier, and that line on it which is exactly in line with one on the true scale. If the vernier were moved along to the position shown in Fig. 3, the true scale would indicate directly that the reading was slightly over 0.500 inch, and the coincidence of the graduation line 15 on the vernier with a line on the true scale, would show the exact reading to be $0.500 + 0.015 = 0.515$ inch; that is, the exact amount (in thousandths with this particular vernier) that the vernier zero has moved past the 0.500 division, is determined, as before stated, by counting the spaces between vernier zero line and that line of the vernier which coincides with one on the true scale.

In Fig. 4 a true scale *S* is shown that is graduated into sixteenths of an inch, and the vernier *V* has eight divisions with a total length equal to seven divisions on the true scale, or 7/16 of an inch; therefore each division on the vernier is 1/8 of 1/16, or 1/128 inch shorter than the divisions on the true scale; so we see that in this case the vernier enables readings to be taken within one-hundred and twenty-eighths of an inch instead of in thousandths as with the one described in the preceding paragraph. The divisions then that may be ob-

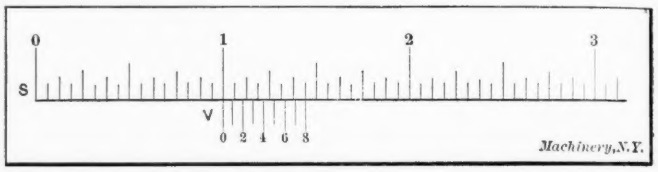


Fig. 4. Scale with Vernier Reading to One-hundred Twenty-eighths of an Inch

tained by a vernier depend altogether on the way the true and vernier scales are graduated. In order to determine the fractional part of an inch that may be obtained by any vernier, multiply the denominator of the finest sub-division of an inch given on the true scale, by the total number of divisions on the vernier. For example, if as in Figs. 2 and 3, the true scale is divided into fortieths and the vernier into twenty-five parts, the vernier will read to thousandths, as twenty-five times forty equals one-thousand. If there are sixteen divisions to the inch on the true scale and a total of eight on the vernier (as in Fig. 4) the latter will enable readings within one-hundred twenty-eighth of an inch to be taken, as eight times sixteen equals one hundred twenty-eight. It will be seen then that each sub-division on the true scale is divided into as many parts as there are divisions on the vernier. If, for example, the vernier of a protractor has, in all, say twelve divisions, evidently each degree may be divided by it into twelve parts or one-twelfth degree. As there are sixty min-

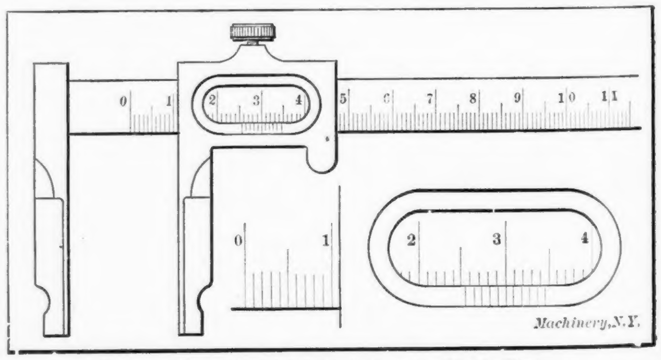


Fig. 5. Caliper Square Graduated on the Metric System

utes in one degree, the protractor would indicate angles within five minutes.

The following is a general rule for taking readings with a vernier: Note the number of inches and whole divisions of an inch that the vernier zero has moved along the true scale, and then add to this number as many thousandths, or hundredths, or whatever fractional part of an inch the vernier reads to, as there are spaces between the vernier zero and that line on it which coincides with one on the true scale.

* With Shop Operation Sheet Supplement.

For example, the zero line of the vernier shown in Fig. 1 is slightly beyond the 0.500 division, and graduation line 15 on the vernier coincides with one on the true scale; hence, the reading is 0.500 + 0.015 equals 0.515 inch. If the vernier is attached to a protractor, note the whole number of degrees passed by the vernier zero mark, and count the spaces on the vernier as before. If the vernier indicates angles within five minutes the number of spaces times 5 will, of course, give the number of minutes to be added to the whole number of degrees.

The application of the vernier to a "Columbia" caliper-square graduated on the metric system, is illustrated in Fig. 5. Here we have, instead of inches, centimeters which are sub-divided into ten parts called millimeters. By the aid of the vernier, each millimeter is again divided into ten parts so that readings can be taken to within 1/10 of a millimeter or 1/100 of a centimeter (0.0039 of an inch). The reading with the caliper set as shown in the illustration is 2 55/100 centimeters, or, as commonly expressed, 25 5/10 millimeters. This particular instrument has on the opposite side of the beam two series of inch graduations which, with the verniers, enable measurements within 1/100 and 1/128 of an inch to be taken. It will be seen that inches may be converted into metric measurement, and *vice versa*, by taking the reading first on one side of the beam and then on the other.

Further information on reading verniers when applied to a micrometer or bevel protractor is given in the Shop Operation Sheet accompanying this number, to which the reader is referred.

* * *

The education of apprentices at the United Shoe Machinery Co., Beverly, Mass., has been arranged along lines similar to those in vogue in Worcester and Fitchburg, and which have previously been mentioned in MACHINERY. The company has organized two classes of twenty-five boys each, recruited from the machine tool department. The city has a technical school supported by the town and the state board of industrial education, and the two classes of boys work alternate weeks in the shop and in the school. These boys are paid half the piece rates that the regular factory employes are paid, and earn at an average of $3 per week, although a few of them earn $5 weekly. Besides these small earnings, of course, they get a thorough knowledge of the use of machinists' tools and, in fact, learn the entire machinist's trade. The class when instructed in the school is taught such subjects as drawing, elementary machine design, mathematics and other practical subjects. They do not receive any pay while attending the school. There is no effort made to educate the students to be superintendents or foremen, but they are fitted to earn a livelihood, and, as one of the men in charge at the Beverly factory says, "If they have the right stuff in them they will get there."

* * *

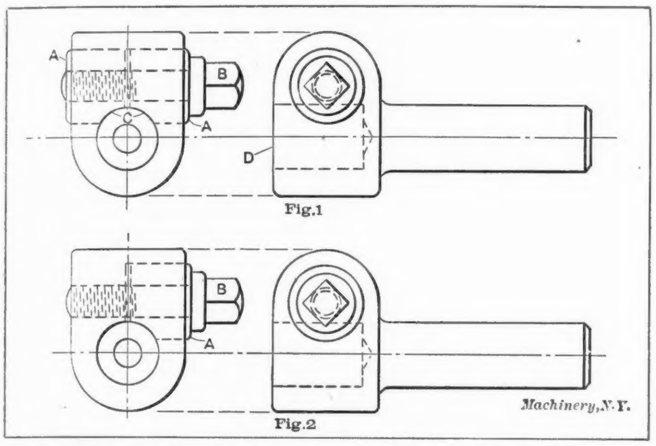
The *Mechanical World* states that aluminum may be etched by the following etching fluid: alcohol, 4 ounces; acetic acid, 6 ounces; antimony chloride, 4 ounces, and water, 40 ounces.

TOOL-HOLDER DESIGNS

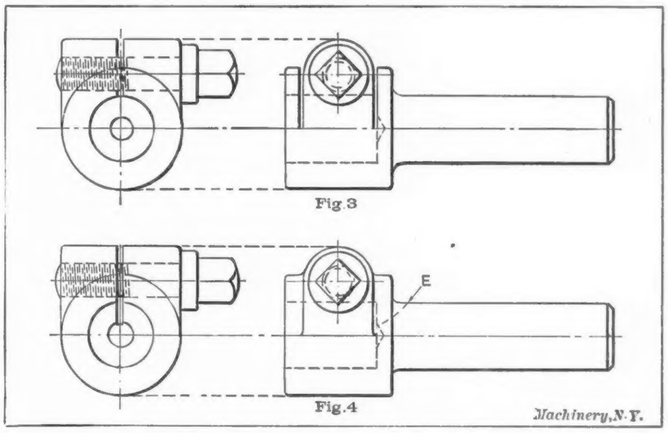
F. P. CROSBY*

A number of tool-holders of different designs for turret lathe and automatic screw machine work are shown in the accompanying illustrations. As many of the types illustrated are widely used and represent standard practice, they are presented herewith for the guidance of tool-makers, designers, or others interested in such equipment.

The binder type of turret lathe tool-holder is shown in Figs. 1 and 2. Fig. 1 illustrates a holder of the double binder type. The hardened cylindrical parts *A*, which should be fitted accurately to the body of the holder, serve to clamp the tool in place. These parts are turned away at *C* to conform to the hole in which the tool is inserted. As may be seen, one of these parts is tapped to fit the screw *B*, which has a collar head bearing against the other part. The clamping action is effected by turning screw *B*, which draws the two parts *A* together, thus binding them firmly against the cutter which is inserted in the bore *D*. The holder shown in Fig. 2 is of the single binder type. The screw *B* is tapped into the body of the holder and only one binding piece *A* is used. These holders are considered to be the best of their class and they can, of course, be made in any size that may be desired. The construction is clearly shown in the engraving.

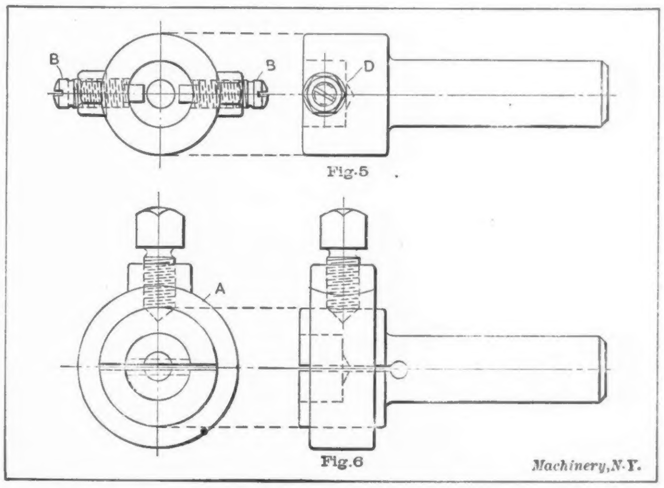


Figs. 1 and 2. Turret Lathe Tool-holders of the Double and Single Binder Type



Figs. 3 and 4. Two Tool-holders of the Compression Type

Figs. 3 and 4 show two holders of the compression type, which for some classes of work is the best. These two holders are practically the same, differing only in the way they are split to obtain the required amount of elasticity for clamping the tool. The holder shown in Fig. 3 is split both across and lengthwise, while the other holder has a single slit lengthwise as far back as *E*. The clamping screws for each tool are only tapped into one-half of the body, so that when they are turned, a clamping action takes place.



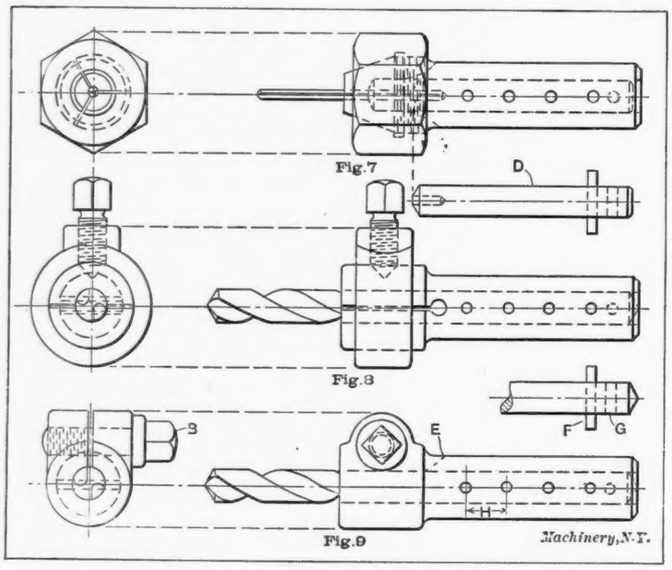
Figs. 5 and 6. Holder for Short Tools with Different Methods of Clamping

Two forms of shallow holders for short tools are shown in Figs. 5 and 6. The taper-point screw style is shown in Fig. 5, the clamping screws *B* being pointed to an angle of three

* Address: 443 North State St., Chicago, Ill.

degrees and fitting into holes drilled in the tool shank. These holes are located at the right distance from the end so that the screws bind the end of the tool shank against the holder. The holder shown in Fig. 6 is of the compression type, the split end being tightened on the tool shank by the collar *A* and pointed screw shown.

Drill holders of the compression type are shown in Figs. 7, 8 and 9. Fig. 7 shows a compression holder of the chuck type which is used for holding small drills. The shank of the drill is soldered to a larger shank, which has a retaining pin engaging the holes in the holder. This enlarged shank, that the small drill is soldered to, is shown in detail at *D*. The small hole in the end for the reception of the drill is plainly indicated by the dotted lines. The holder shown in Fig. 8 is provided with a collar and pointed screw for clamping the drill. With the exception of the method of clamping, this tool is similar in other respects to the one shown in



Figs. 7, 8 and 9. Three Types of Drill Holders

Fig. 9. The latter is slotted lengthwise as far back as *E*, and the drill is held in position by the collar-head clamping screw *B* which is tapped into one side of the holder. The shank of this holder has drilled into it a number of holes in regular order as shown. The shank of the drill is fitted with the pin *F*, which prevents the crowding back or turning of the drill in the holder. An extra hole *G* is provided for the pin,

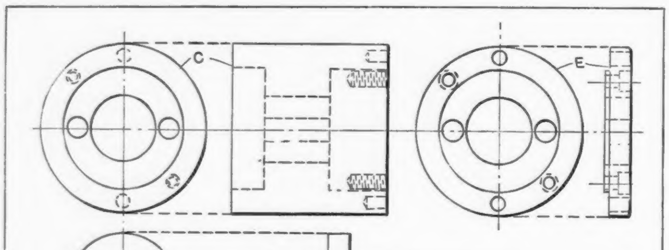


Fig. 10. Assembled and Detail Views of a Die-holder

and the distance between the two pin holes is equal to one-half the dimension *H*. The clamping screw on a holder of this type needs only to be tightened enough to bring the tool in line.

Fig. 10 shows both assembled and detail views of a solid shank die-holder. The reference letters used in the detail views are the same for the corresponding parts in the assembled view. The shank and the clutch *A* is made in one piece from tool steel, and it is tempered and ground. In the end of this shank there is a clearance hole *B*, the depth and diameter of which is sufficient to give the required clearance for the work. The sleeve *C*, which is accurately fitted to the shank,

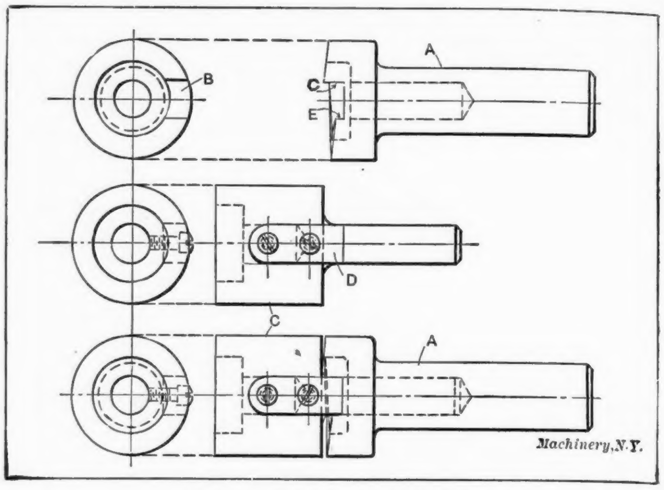


Fig. 11. Another Type of Die-holder

has attached to it the die, two of the contact pins *D* for driving the die, and the backing-off plate *E* with its contact pins D_1. The way in which the backing-off plate is held in place by screws and dowels is clearly shown in the illustration. The contact points at *F*, in case the shank should become worn, can be trued by grinding. The contact pins in case of wear can be removed and turned one-quarter way round.

A die-holder of the semi-hollow shank order is shown in Fig. 11. The shank *A* of this holder should be made of tool steel tempered and ground. On the enlarged end of the shank is shown a left-hand helix which is cut from the slot *B*. If the holder is to be used for cutting a left-hand thread, a right-hand helix has to be provided. The die is held in the

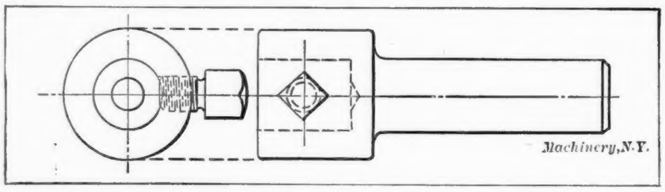


Fig. 12. Tool-holder of Objectionable Design

swiveling part, *C*. which is fitted to the shank as shown. In operation, when the turret comes to a stop, the clutch *D* disengages with the point *E*, and in backing off it is in contact with the point *C*. The clutch is made of tool steel, and is tempered and fitted to the die-holder in a manner clearly indicated in the illustration.

The tool-holder shown in Fig. 12 is one in common use, but the best place to put it is in the scrap pile, as it is simply impossible for any workman to adjust a tool in it that will be lined up properly. It is supposed that the reason for using this type of holder is to save a little on the cost. Such a tool, however, will prove to be a very poor investment.

* * *

According to the provisions of the new custom tariff of Norway, machines, motors and apparatus not manufactured in the country will be admitted free of duty. As the machine industry in Norway is comparatively undeveloped, there are a great many machines and machine parts which are thus placed on the free list, among which may be mentioned band saw blades, circular saw blades, steam hammers, pneumatic drills, steam turbines, ball bearings, link belts, etc. The complete list of the machinery admitted free of duty may be found in the November 19, 1909, issue of the *Daily Consular and Trade Reports*, published by the Department of Commerce and Labor, Washington, D. C.

* * *

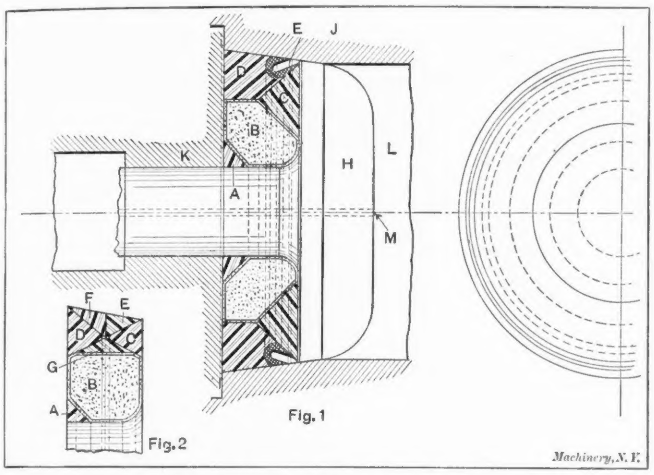
Don't forget that the top of a work-bench should slant back toward the wall.

A GAS CHECK FOR BIG GUNS

ROBERT O'NEAL*

In the large guns in use by the government, as in most other things, it is the little parts that make the great engines of war of real value. This is clearly illustrated by the fact that a fifty-thousand dollar implement of modern warfare may be temporarily put out of commission by the catching on fire of a small pad used in the construction of what is known as the gas check. This little pad which is made of canvas, hair, tallow, beeswax, etc., is worth about thirty cents, which is an insignificant sum when compared with the cost of the gun, complete; but the gun without it is about as dangerous at one end as at the other.

In Fig. 1 of the accompanying engraving is shown, in cross-section, the interior of that part of a large gun with which this little pad has to do, and in Fig. 2 the present method of



Sectional View of Gas Check for Big Guns

the construction of the rings of a gas check is illustrated. The difference between the two checks is clearly perceptible, and the advantage of that shown in Fig. 1 over that of Fig. 2 will, I think, be readily seen when the matter is fully explained.

In order to show as clearly as possible the use of the rings and the pad, it will be necessary to go into the matter somewhat in detail. In Fig. 1, *H*, *J*, *K*, and *L* represent the mushroom, the gun, the breech-plug and the powder or combustion chamber, respectively. When the charge is rammed home, the breech-plug—the face of which is shown in contact with the rear face of the rings *A*, *D*, and the pad *B*—is swung into position and turned through an arc of 40 degrees, it having entered an interrupted thread of sixty one-hundredths inch lead; this brings the mushroom *H* firmly against the wall of the gun *J*, through the contact of the rings *A*, *C*, *D*, and the pad *B*. Now, the powder charge in the chamber *L* is ignited through the vent *M*, and a pressure ranging anywhere from forty to fifty thousand pounds per square inch is generated within the chamber. Against this pressure it has been found impracticable to devise a method of holding the mushroom *H* sufficiently hard against the wall of the gun to prevent the escape of gas; therefore the gas check is necessary, as the mechanism must be free-working to allow of easy manipulation by the gun crew.

As the mushroom moves back, the pad *B* is caught between the members *A* and *C*, and as *C* is held rigid, the tendency is to reduce the thickness of the pad *B* and increase its diameter. This directly increases the diameters of the rings *C*, *D*, *E*, *F* and *G* when they are constructed as in Fig. 2, and brings them up against the wall of the gun with a pressure directly in proportion to the pressure of the gases in the combustion chamber, according to the laws of force as applied to the wedge; but this increased diameter is accompanied by a proportionate increase in the opening where the ring has been cut. The opening necessary for this expansion, though small (about 0.006 of an inch), like most little things, plays an important part, in that it allows the gas to escape through it to the pad *B*. As the temperature of this gas is that of a white heat, and acting under a pressure sufficient to throw a five-hundred-pound projectile about twelve miles in something less than half a minute, it is safe to say that this little mass of combustible substance can not long resist the onslaught of such a potential factor of destruction. Quite often only one charge is fired, when it is found necessary to renew the pad, and rarely can over three or four shots be made without renewal. While this does not require any great amount of time, nevertheless, it requires the removal of the firing lock (not shown here), the mushroom, and the dismantling of the rings; in addition the danger of fire in the turret is incurred while removing the burning pad.

It will be seen at a glance that the difference between the two gas checks illustrated lies principally in the construction of the ring *E*. In Fig. 2 this ring is of triangular cross-section and of solid metal, necessitating its being cut in order to increase its diameter when the gun is fired. In Fig. 1 ring *E* is of a U-shape in cross-section, which will allow of its being opened out to fill the space between the angular face of the ring *C*, and the wall of the gun, without cutting it, for, when the mushroom *H* recedes, the ring *C*, being solid, is carried back with it; the pad *B*, in either case, is pressed thinner and consequently larger in diameter, thus forcing the ring *D* out and hard against the wall of the gun. The gas, passing between the mushroom *H* and the wall of the gun *J*, is caught between the legs of the U-shaped ring *E*, which is being firmly supported on its inner side by the face of the ring *C* and on the outer side by the wall of the gun, while the round portion is sustained by the concave surface of the ring *D*. The pressure of the gas forces the legs outward against these three surfaces with a pressure equal to that within the chamber, and a joint is made between these surfaces through which the gas cannot possibly escape.

This design of check could be constructed to take the place of the one now in use without in any way altering the standard parts of the gun, as the set of rings shown in Fig. 1 could be made to fill the space occupied by the set shown in Fig. 2; and, if constructed with care, I see no reason why they would not last as long as the gun, or, at least, until general repairs are needed, which is usually after approximately fifty shots have been fired.

* Address: 1504 E. Monument St., Baltimore, Md.

* * *

KINDLINESS AN ASSET IN MANUFACTURING

It may seem a long step from machine construction to the sentimentalism of smiles and kind words, but nevertheless these two items play an important part in many successful manufacturing plants. The object sought by a manufacturer is efficiency—efficiency on the part of the individual members of the organization as well as on the part of the machinery employed. A great deal of time and thought is expended on making the machinery efficient. Experiments are made, careful records are kept, and the best results utilized; but little thought is usually given to increasing the efficiency of the "man who works with his hands," and that often lacks system and appreciation of the final effect. Sometimes attempts are made to increase the efficiency of the men making up the organizations by methods entirely erroneous, not to say culpable, and which in the long-run prove as costly as they are ineffective.

There is, however, an inexpensive method of increasing the efficiency of the personnel in any organization. While fair compensation, and what is generally considered fair treatment are absolute essentials, a great deal can be both lost or gained by the general attitude of the employers and men in charge of the various departments. A kind word, an appreciative smile, a commendation for work well done, for instance, will often increase the efficiency, and are more effective in eliminating friction, than a so-called welfare department planned on an elaborate scale.

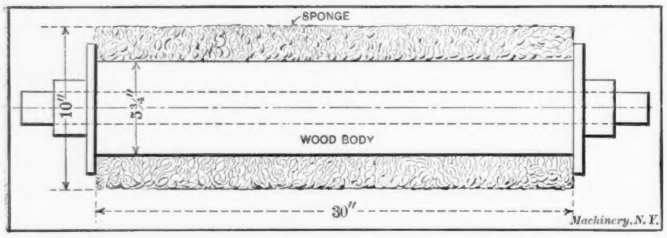
The efficiency of the mechanical element of the industries has been raised to a high standard, and the efficiency of the human element should be raised to an equal height by methods which will be of lasting effect both in a factory and without. If you never use smiles and kind words, try them, and you will find that the effect will be immediate, not only on those around you, but on yourself.

LETTERS ON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

INGENIOUS METHOD OF TURNING A SPONGE-COVERED ROLL

A roll formed of strips of sponge and a wooden body, had to be turned true, and the writer was asked to do the job, which was wanted in a hurry. You can bet that there was



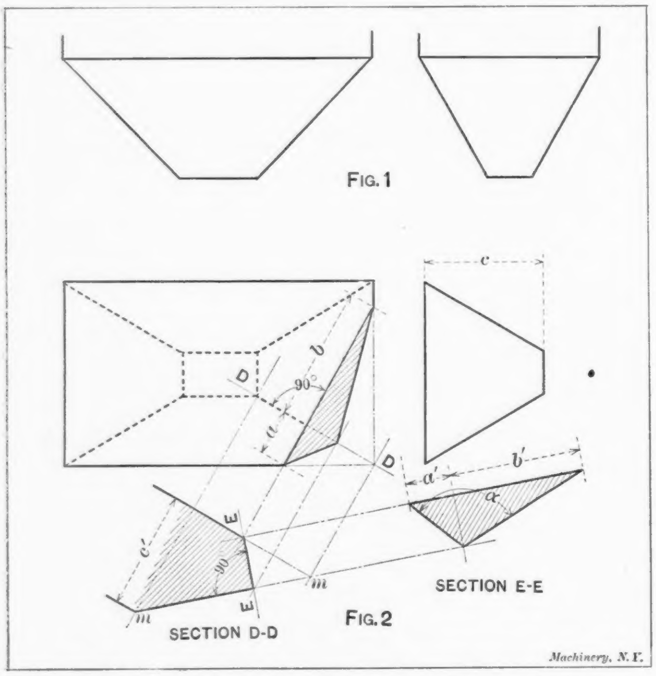
Wooden Roll with Sponge Covering which had to be turned true

some question as to how it was to be done. The sponge strips were fastened by brass tacks to the wooden body. These tacks were placed as near together as possible, there being about sixteen of them to each block of sponge. After the roll was built up in this way, the method of getting it to the required diameter proveu to be a sticker. There were enough suggestions offered to fill a book, but finally the following method was tried with considerable success. As the temperature out-of-doors was near the zero mark, the roll was placed outside on two wooden horses with blocks arranged on either side of the shaft so that it could be turned. With the aid of a dog on one end of the shaft, the roll was then revolved, while a fine spray of water from a hose was turned on it. In about twenty minutes the roll was frozen solid; it was then placed in the lathe and two cuts were taken over it, which completed the job. After the ice melted, the sponge covering was found true.

Lewiston, N. Y. CHARLES H. LAKE.

ANGLES OF HOPPER SIDE INTERSECTIONS

In building a steel hopper of the form shown in Fig. 1, it becomes necessary to know what angle the sides of the



Graphical Method of obtaining the Angle formed by the Tapered Sides of a Hopper

tapered portion make with each other, in order to properly bend the flange or splice plate, for the corner, as the case may be. This angle can be obtained graphically, as shown in Fig. 2. For clearness of demonstration, consider a block of the same shape as the lower portion of the hopper, with a corner cut off in a plane perpendicular to the corner *D-D*, as shown. To obtain the angle, first lay out a plan of the outline of the block as it would be before the corner was cut off; then draw section *D-D*, making *c'* equal to *c*. Draw any line *E-E*, perpendicular to *m-m*, and then projecting upward, obtain a plan view of the surface *E-E*, or a view representing the block as it would appear from above, with the corner cut off. Now draw section *E-E* making *a'* equal to *a* and *b'* equal to *b*. Then *α* will be the required angle. CHAS. E. EVANS.

Aurora, Ill.

[The diagrams of the Data Sheet for April, 1908, will be found very convenient for obtaining the angle formed by hopper sides.—Editor.]

MILLING A CORRECT BEVEL GEAR

In this article a method of cutting bevel gears is described which has been in use now for about two and a-half years, in a number of shops in this vicinity.

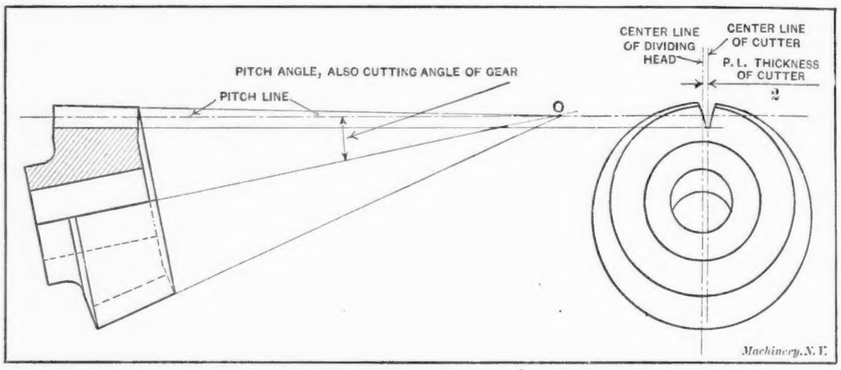


Illustration showing Method of Setting Gear Blank with Relation to Cutter

While the method is perhaps a trifle difficult to understand, as it was to work out, the results are so satisfactory as to more than make it pay. It is applicable to all cases excepting miters of very coarse pitch and few teeth and where strength is an essential feature. There is a slight excess depth at the small end of the tooth which, ordinarily, is entirely negligible and only in unusual cases is so objectionable as to make this process impracticable.

The advantages sought for and gained are these: A smooth-running bevel gear milled scientifically without "cut-and-try"; a pair of bevel gears which mesh perfectly at the pitch-line; a bevel gear which requires no filing at the small end of the tooth to make it run smoothly; and, as important

PITCH LINE THICKNESS OF B. & S. BEVEL GEAR CUTTERS

Diam. Pitch	2	3	4	5	6	7	8	10	12	14	16	20
Thickness	.513	.334	.257	.204	.169	.145	.126	.100	.082	.070	.060	.047

as anything, a method that saves a large amount of time and does away with uncertainties in bevel gear cutting.

These results are accomplished as follows: The regular bevel gear cutter is used. The gear to be cut is mounted as usual in the dividing head, but it is set up so that the working or pitch angle of the gear is the cutting angle; in other words, so that the pitch line of the tooth running to the common center *O* of the gears is parallel with the bottom of the cut, as shown in the accompanying illustration. The milling machine table is not swivelled in any case.

The cutter is set for depth, as usual, from the high point on the gear to be cut. The saddle of the machine is moved so that the vertical center of the cutter is to one side of the vertical center of the gear, a distance equal to half the pitch line thickness of the cutter. A cut is then taken all around, for each tooth. This finishes one side of the tooth. The

other side of the tooth is finished by moving the saddle in the opposite direction, so that the vertical center of the cutter is on the opposite side of the vertical center of the gear, a distance equal to half the pitch line thickness of the cutter as before. Before the cut is taken the dividing head spindle is rotated so that the amount taken off this opposite side of the space is such as to leave a tooth of the correct thickness at the back, which may be easily determined by trying a spur gear cutter of the same pitch and number of teeth, or tooth gage, or spur gear tooth of the same pitch, or otherwise. This being done, the cut is taken all around, which finishes the gear.

On examination, by actual test, careful measurements or analysis of the method, it will be found that the results sought have been secured and the gears will run proudly, as self-respecting bevel gears ought to run.

Muskegon, Mich. CHAS. A. KELLEY.

INTERESTING WORK IN AN EXPERIMENTAL SHOP

No one class in society has a corner on inventive genius; to-day, the doctor conceives the "best thing yet," while on

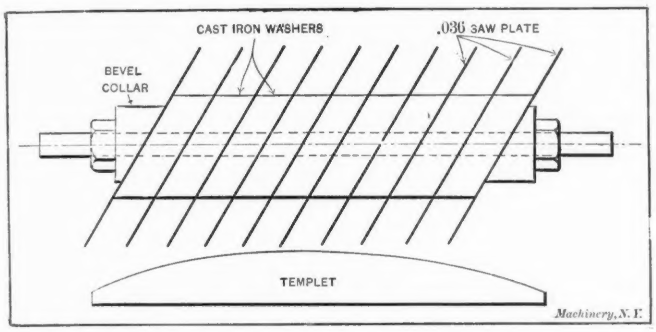


Fig. 1. Steel Disks which were turned to conform to the Templet

the morrow the chances are that it will be the laborer who is propounding something that will bring him fame and fortune. The machine shop has been and will continue to be the mecca of inventors, and a shop catering to experimental work is brought face to face with constructions and schemes as diversified as are the stations in life of their sponsors. To save the inventor from being "stung" for special tools and fixtures which he is sure will be needed when he gets to the manufacturing stage, the shop man may have to use diplomacy, and then, on his own side, resort to some homely short cuts to get the work through without these special tools.

Figs. 1 and 2 show pieces of work turned out for different

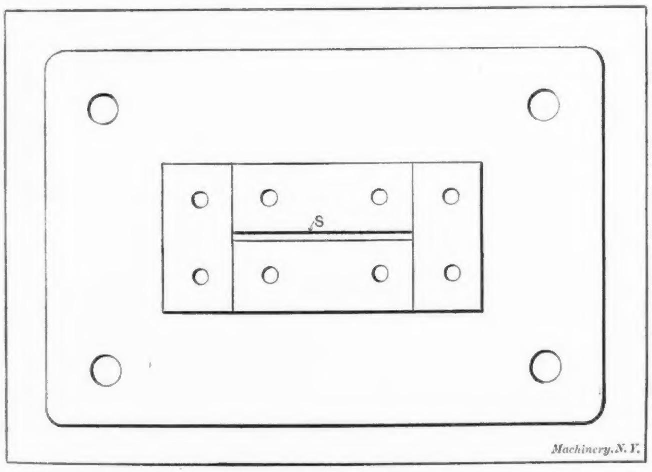


Fig. 2. Four-piece Die for Experimental Work

inventors (each with plenty of money to spend) at a fraction of the outlay that might have been put upon them. The mandrel in Fig. 1 was loaded with carbon steel disks that had to be turned to fit a templet. These disks, instead of being at right angles to the center line of the mandrel, were at an angle as shown, an effect produced by using a beveled collar on each end and loose fitting spacers between the disks. It can readily be seen that to turn these disks, projecting beyond the spacers from 3 to 5 inches, was impossible by ordinary means unless a rigging was made to follow in and out and back and forth as each one was cut separately—all of which was practically out of the question. The short way out of it was to slip on each end of the mandrel a board the size of the largest disk blank and to wrap about the whole several thicknesses of heavy manilla paper and tack it securely to the boards. After filling the disks with lead both the lead filler and the disks were turned off to the shape of the templet in quick time.

Fig. 2 shows a die and block that were substituted for the inventor's specifications for a solid tool steel die with a slot *S* 3/32 by 3 inches and absolutely to size. The four-piece die illustrated was simple to make as compared with the solid one, had ample security against spreading when set into the block, could be sharpened as often as necessary, maintained its size, and presented no risk in hardening.

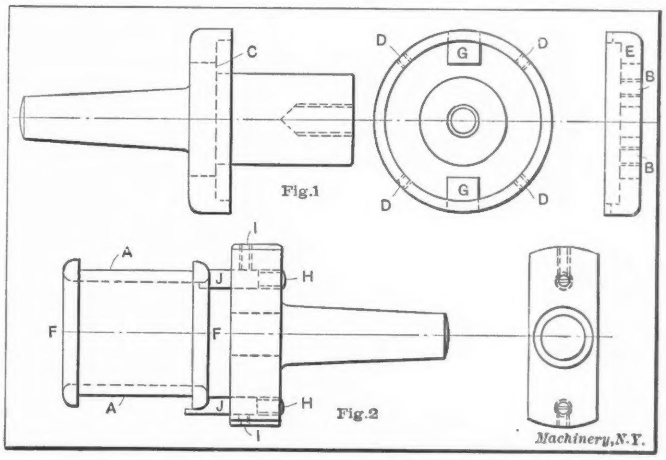
And like so many that have gone before, neither of the above pieces was ever used long enough to keep the rust off and neither produced dividends on the investment.

Middletown, N. Y. DONALD A. HAMPSON.

MACHINING SPLIT BEARINGS

An interesting problem in the machine shop is to bore and and turn split bearings accurately. The success obtained by the use of the following methods, leads me to sumbit them to the readers of MACHINERY. The bearings are made of brass; when received from the foundry, they are placed in a shaper and planed on the faces *F-F* to a certain height from the back. After this operation, they are taken to the forge ana sweated together. While this is not absolutely necessary, it facilitates handling the work in the next operation of chucking and boring.

The brasses are held by a pair of false jaws, which were cast



Mandrel on which Bearings are turned, and Special Tool used for Rounding Corners

for the turret lathe, and which are turned and recessed so as to clear the flange of the brass and bear on the faces *A*. The boring is done with a bar and fly-cutter, the bar being supported by a bushing in the spindle of the machine. The front face and flange are next squared and turned off before the work is removed from the chuck. It was to shorten the time required and facilitate the operation of turning the brasses that the mandrel shown in Fig. 1 was designed. The shank was made to fit in the headstock; and as the mandrel is very rigid, it is not necessary to support it by the tailcenter; consequently, high speeds can be used and there is no danger of a center becoming heated. The brasses are placed on the mandrel with the end previously finished in the turret lathe against the finished face *C*. They are locked in place by four set-screws *D*. A C-clamp is placed on the outer end of the brasses and is left there until that end and flange are finished. The cap *E* is then placed over the outer end of the brasses and the clamp is removed. This cap is fastened to the mandrel by a bolt in the center. Set-screws are provided in holes *B* to aid in removing the cap, as it is made a snug fit over the work, to prevent the latter from spreading during the process of turning. The over-all measurements are taken

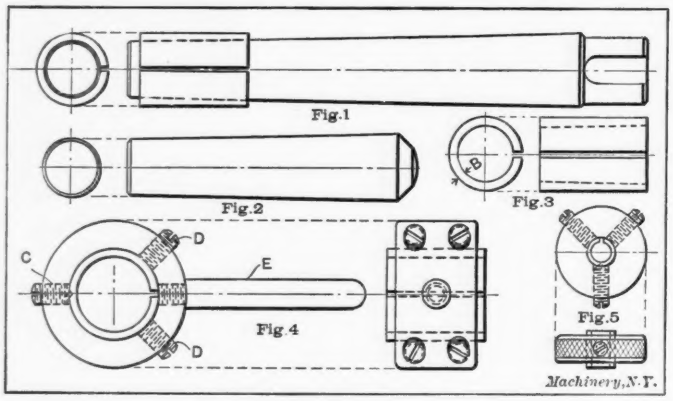
through the port-holes *G*, which are cut in the mandrel for this purpose.

After the trial lot of brasses had been completed, the radius- and fillet-turning tool, shown in Fig. 2, was designed. This tool is held by a shank in the tailstock and with it the corners of the bore and flange are rounded with a greater degree of accuracy than is ordinarily obtained when the shape of these surfaces is left to the judgment of the workman. The cutters *J* are made of drill rod, and they may be adjusted by the screw *H* and locked by the screw *I*. Direct evidence as to the time-saving qualities of the foregoing method, was given when the cost clerk made inquiry about the shortness of the time listed on the daily time cards for the lot of work which was machined by these tools.

Salem, Mass. JOHN F. WINCHESTER.

LAPS AND POINTS ON LAPPING

The laps which are shown in the accompanying illustration are excellent designs for both the outside and inside lapping of cylindrical parts. Fig. 1 shows an inside lap with the arbor in place. The included angle of the taper of this arbor should be about 2 degrees; this is considered great enough for any kind of work. The lap proper, or the part that is in contact with the work, is made of bolt copper, and is shown in detail in Fig. 3. Cast iron and lead are sometimes used, but copper is the best metal for hardened work. The lap is split as shown, to allow it to expand as it becomes worn. The length of the lap should be somewhat greater than the length of the hole to be operated on, and the thickness *B* should not be more than 1/6 or less than 1/8 of the diameter of the work.



Laps for Inside and Outside Work

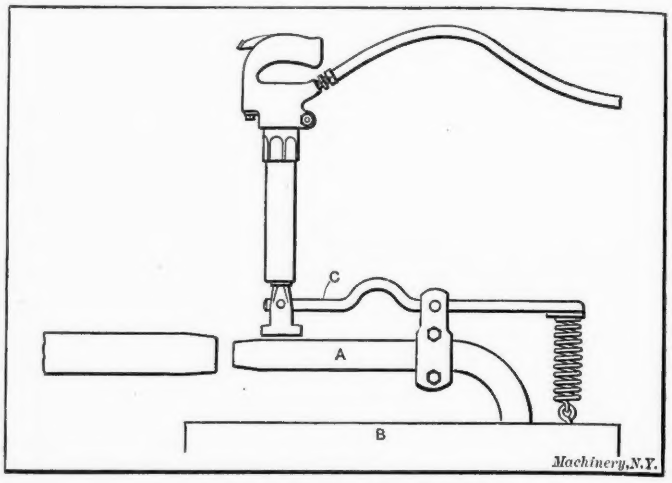
When making these laps, especially small ones, a hardened swedging plug, (Fig. 2) that is ground to the same taper as the arbor, can be used to advantage for tapering the hole through the lap before it is turned and slotted. If in the operation of lapping, the hole becomes "bell-mouthed," that is, enlarged at the ends, this is caused by the introduction of sharp emery from time to time as the hole is being lapped. To obviate this, the lap should be cleaned of all loose emery and expanded by driving the arbor farther into it. The hole is then dry lapped by using only the emery that sticks or is charged in the lap. This process must be repeated occasionally until the proper size is obtained. If the operator is careful to see that the emery used is not too coarse, and the lap is kept expanded to fit the work at all times, the result will be a perfectly straight hole. It takes considerable practice before one can use a lap and keep it from getting lumpy. If this occurs, the high spots must be removed with a file, and the lap kept a close fit to the work. The work should always be finished to size with the lap dry and well fitted to it.

Fig. 4 shows an outside lap. The proportions of the lap proper should be the same as were given for inside laps. The same method of procedure described for inside work should also be followed, *viz.*, the lap must be freed from oil and loose emery from time to time as the work progresses. The pointed screw *C* keeps the lap from slipping out of place, and the adjusting screws *D* compress it to fit the work. A handle *E* should be used on all laps of large size, as it will be found much more convenient than a lathe dog, which some workmen use for moving the lap. Fig. 5 illustrates an outside lap and holder for small work, say less than ½ inch in diameter. Laps of this size are not provided with a handle, but are knurled on the outside as shown. F. P. CROSBY.

Chicago, Ill.

PNEUMATIC FLUE WELDER

An inexpensive flue-welding device that was designed to handle a large repair job that came in unexpectedly is shown in the accompanying illustration. It consists of a mandrel *A*, which is attached to a cast iron block *B*, and a pneumatic hammer (equipped with a swage), which is mounted on a lever *C*. As the illustration shows, this arm is fulcrumed to a bracket on the mandrel and is spring supported. The ends of the long pieces were first scarfed by lowering the back end of the tube until it was about six inches below the level of the mandrel. This gave a taper of approximately ¼ inch to the inch. After all the long pieces were scarfed, short pieces about 8 inches long were placed in the furnace and heated on one end so that they could be drawn to a feather edge. This was also done under the pneumatic hammer. After all the flues were scarfed and the short ends made ready for welding, the horse upon which the outer ends of the flues had rested, was raised to bring the work level with the mandrel. All short pieces were then put on the flues while hot so they would shrink tightly in place, thus insuring a good clean weld by preventing any dirt from getting between the surfaces to be welded. After all flues were treated in this way the furnace was cleaned, and the welding done at a speed which would make many of the costly flue-welding machines hustle to keep up with. T. O. MARTIN.

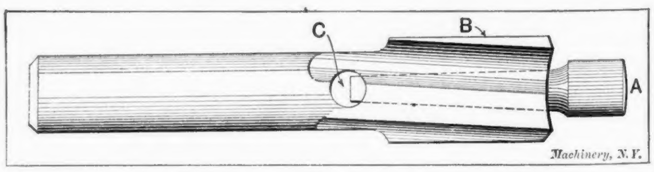


Inexpensive Tool for Flue Welding

Jackson, Tenn.

COUNTERBORES WITH REMOVABLE PILOTS

By making a counterbore with a removable taper-shank pilot the value and efficiency of the tool is increased fully 100 per cent. Once in a great while a toolmaker is found who makes them this way, but it is not the general practice. The illustration shows very plainly the design we use, excepting for very small sizes. A hole drilled at right angles to, and at the end of the taper, makes the removal of the pilot easy by inserting a drift. Standard taper pin reamers are generally used for reaming the pilot seats, thereby making the different pilots interchangeable within certain limits.



Counterbore equipped with Removable Interchangeable Pilot

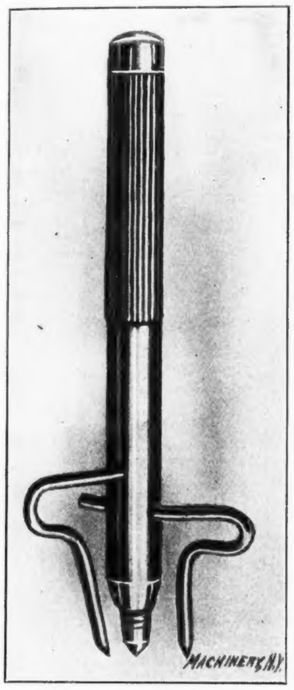
When the matter is carefully considered it is easily seen that a great combination of sizes can be made with but a few counterbores and pilots. Then again, if a pilot breaks when being used (which very often happens with the solid variety), it is but a moment's work to remove the broken part

and replace it with a new one. Last, but not least, is the convenience offered, when sharpening on a grinder, by removing the pilot. The counterbore may be held in a taper collet, if it has a taper shank, or if straight, in a simple form of chuck, fitted to the spindle of the grinder and made straight inside to fit the shank of the tool. The extra cost of the taper hole in the body and turning the pilot, is very slight when compared with the usefulness and long life of counterbores made in this way. A. DANE.

Buffalo, N. Y.

SPACING AND OUTLINING PRICK-PUNCH

By the use of the prick-punch shown in the accompanying illustration, the centers for holes to be drilled within any outline can be located, no matter what the shape, without making extra lines for guiding the point of the punch. For example, if the central part of a die is to be drilled out with, say, a ¼-inch drill, the drill spacer on the punch is set to ¼ inch and the guide point to ⅛ inch full; then no matter what shape is followed the centers will be ¼ inch apart, and ⅛ inch from the line, or a distance equal to the radii of the holes to be drilled. This punch, which is 3½ inches long, is made of 5/16-inch drill rod. The end is drilled and tapped for a threaded center point made from No. 12 drill rod. Care should be taken to see that the threaded end bears against the bottom of the hole so that the shock of the hammer blow will come on the end of the pin and not on the threads, as would be the case if the point were not screwed home. The thread that is exposed is flattened on opposite sides so that the point can be tightened or removed with a pair of pliers or a small wrench. Several points can be made at once by threading a piece of drill rod and pointing and cutting off pieces to the required length while holding the rod in a chuck. These points should be hardened all over and drawn to a light straw color. Both the spacing and the guide points are made of No. 42 drill rod; they are hardened in oil and given a spring temper. These points slide through the body and are adjusted to any length desired. They are held in place by a small screw which is tapped through half of the punch body. The bow or crook in the wires is to give them sufficient spring to adjust themselves. This is a laying-out tool, and is not intended for heavy work. For large drilling, it should be followed by a heavy punch to deepen the marks. WILLIAM A. PAINTER.


Prick-punch with Spacing and Guide Points

Pittsburg, Pa.

INSIDE CALIPER WITH INDICATOR ATTACHMENT

An ordinary 6-inch inside caliper that has been changed somewhat in form to adapt it to precision work, is shown in Fig. 1. One of the legs of the caliper was hammered or upset to make it thick enough to be slotted for an indicator arm, and the other side was cut off to the correct length. This indicator or registering arm is 3½ inches long, and it has a travel of one inch at the point. It is 1/32 inch thick, and the graduated blade (shown more clearly in Fig. 2) is of the same thickness. The latter is recessed in the caliper leg and is fastened with two rivets. A travel of 0.025 inch on the caliper end is equivalent to ½ inch travel on the graduated leg, the pivot or axis multiplying twenty times. The working point *A*, Fig. 2, is made of drill rod and is hardened and rounded on the end. The smallest diameter of the point is 0.050 inch and it projects about 0.065 inch when pushed out against its shoulder. Normally this working point is held against its shoulder by a flat spring *B*. In use, the caliper is adjusted until the pointer stands at zero or at the center of the graduation. As shown, the limit of travel is 0.025 inch in either direction which is sufficient for ordinary work. The caliper is set to the required size, for close fits, with a micrometer, and allowance is then made from the indicator. This tool is especially useful when boring, to test the truth or varations of the work or in making an allowance for driving or running fits. The attachment is, so far as I know, original, as I have never seen anything like it in use, or in catalogues. WILLIAM A. PAINTER.

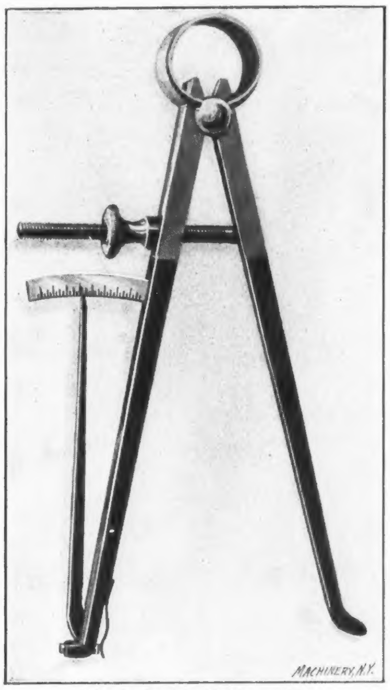


Fig. 1. Inside Caliper with Indicator

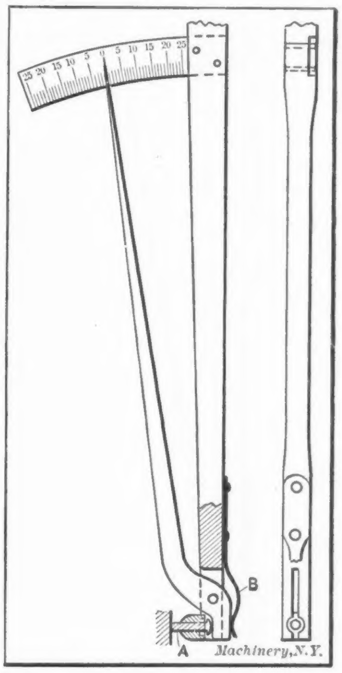
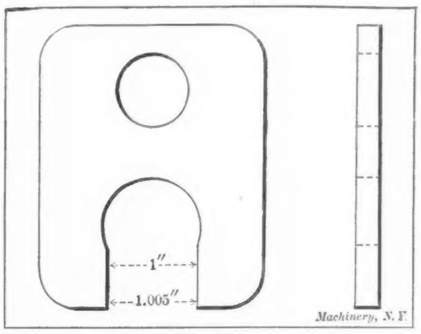


Fig. 2. Detail of the Inside Caliper Indicator Attachment

Pittsburg, Pa.

SNAP-GAGE WITH TAPER TO ALLOW FOR FINISH

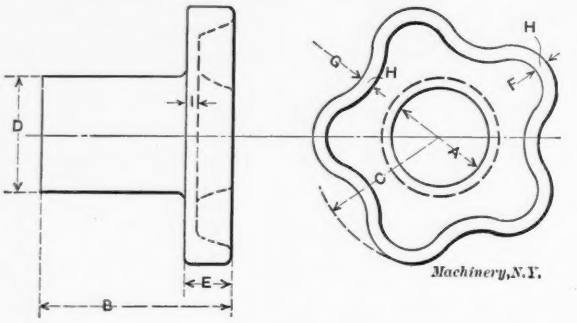
A number of armature shafts had to be finished in the lathe after being first roughed out in a screw machine, and micrometers were being used for measuring them; but there were not as many micrometers available as there were men on the job. Ring-gages were also used for the different sizes of shafts, but the men got along much better when using the micrometers, as they had to allow for finishing with emery cloth, and they could make this allowance much easier with micrometers than with the ring-gages. A lot of snap-gages were then made, which helped us a great deal. They were just like a regular snap-gage, except, instead of grinding the jaws straight all the way, they were ground straight and then re-ground 0.005 inch taper on one side, as indicated in the accompanying illustration, back within a short distance of the end. This left a short part of the gage jaw straight and the rest taper. The men using this style of gage soon became accustomed to it, and the allowances for filing and polishing were easily made. H. D. S.



Snap Gage with Tapered Jaw to allow for Finish

STAR HAND-WHEELS FOR JIGS

An excellent design of hand-wheel for use on jigs, etc., is shown in the accompanying illustration. The dimensions for five different sizes of these hand-wheels are given in the table beneath the engraving. After five years' experience, I have found that the particular style illustrated is well adapted to

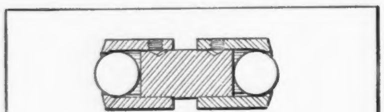


A	B	C	D	E	F	G	H	I
3/4	1 3/4	1	1	3/8	3/16	5/16	1/8	1/8
1	1 7/8	1 1/4	1 1/8	7/16	5/16	7/16	1/8	1/8
1 1/8	2	1 1/2	1 3/8	1/2	3/8	9/16	3/16	3/16
1 1/2	2 1/8	2	1 5/8	9/16	1/2	11/16	3/16	3/16
1 5/8	2 1/4	2 1/2	1 3/4	5/8	7/8	7/8	3/16	1/4

all-around jig use. By having the castings solid, they may be tapped out for any size thread and used in place of nuts, or a plain hole may be drilled and the castings pinned to round stock. The long stem gives a good length of thread for wear and brings the hand-hold far enough from the jig to prevent the fingers and knuckles from striking it. The star design gives a good grip for the fingers, and, as the top is hollowed out, the palm of the hand forms a suction, thus giving a stronger hold. This type of wheel is also easy on the operator's hands, and it is cheaper to produce in quantities, and more powerful than knurled nuts, pins, thumb-screws, etc. This wheel adds to the appearance of a jig and it can be operated very fast. JIG AND TOOL DESIGNER.

AN INEXPENSIVE SET OF GAGES

As our manager could not be persuaded that a set of gages would be a profitable investment, I decided to make a set; but this did not appear, at first, like an easy job, as there was only a pair of one-inch micrometers to measure with. However, a highly satisfactory set of inside and outside gages, varying by ½ inch, was made. The inside gages have hardened ends, which may be replaced at any time at a cost of only a few cents.



Figs. 1 and 2. Inside Gages made by using Bicycle Balls at the Ends

Cast iron rings for the outside gages were first roughed out to within 1/32 inch of their finished size. To make a two-inch inside gage, a piece of half-inch round, cold rolled steel was first accurately finished to a length of exactly one inch. Two half-inch bushings, ¾ inch long, were then turned on the screw machine and reamed part way through, a shoulder being left at one end to retain the half-inch balls which were placed in the bushings, as shown in Fig. 1.

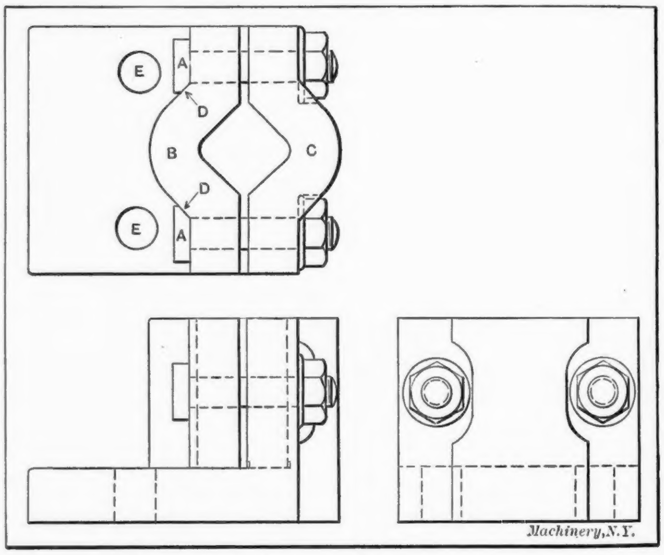
Bicycle balls were used, and when tested they were found to be within 0.0001 inch of being accurate; therefore I was satisfied that the 2-inch gage was all right. In order to make sure that the balls came up tight against the end of the rod, set-screws were put in the bushings and the rods spotted so that the point of the screw would draw the bushing and with it the ball back against the rod. When this inside gage was finished the outside gage was bored to fit it. To make the 2½-inch gage, one of the bushings from the 2-inch size was removed, and replaced with one a half inch longer, as shown in Fig. 2. In this longer bushing, two balls were placed, thus making it 2½ inches in length. It was then used for turning the 2½-inch outside gage. The one-ball bushing was then replaced and a drop of solder put on the set-screw to prevent its being tampered with. The 2½-inch outside gage was next used as a master, and a rod was dressed down until with one ball at each end it fitted the 2½-inch gage. This process was continued until a number of gages of different sizes had been made. S. A. McDONALD.

Candiac, Canada.

[If gages produced by the foregoing method are to be accurate, it will, of course, be necessary to have a good fit between the ball retaining sleeves and the central plug, and also between the balls and the sleeves, so that the tightening of the set-screws will not cause the centers of the balls to be moved out of line.—EDITOR.]

FIXTURE FOR PUNCH-HOLDERS

A fixture designed for holding punch-holders on the face-plate, surface grinder, or miller, is illustrated herewith. In most shops the die-maker is compelled to use a substitute makeshift affair, which is merely a solid hub and flange with a hole bored and a set-screw in the side. The objectionable



Fixture for Holding Punch-holders of Various Sizes without marring them

features of this "job-spoiler" are legion, the worst one perhaps being the abominable set-screw (or rather the point of it) which, when tightened, not only throws the work over on an angle, but, when set up hard (as is necessary when taking heavy cuts on the miller), leaves unsightly marks in the soft shank.

The design submitted not only eliminates this annoyance, but it is preferable in every way. Obviously, it will take shanks a trifle over or under size as well as all standard sizes in use, the advantage of which should be apparent to any one caring to utilize the space that a half dozen or more of the other kind take up. As the illustration shows, the design of the fixture is very simple. The bolts *A* are a drive fit in casting *B* and a sliding fit in casting *C*. These bolts should have the under edge of the head cut away on one side, as shown at *D*, so they will lock against the side of the casting and not turn when the nuts are set up. The fixture is fastened down in the usual way by T-bolts, holes *E* being for that purpose. If the fixture is to be used for very large shanks, these holes should be placed far enough back so as to allow room for sliding jaw *B*. When so made, the fixture is excellent for grinding sub-press tools, the plunger being removed and held in the same manner as the punch shank. This fix-

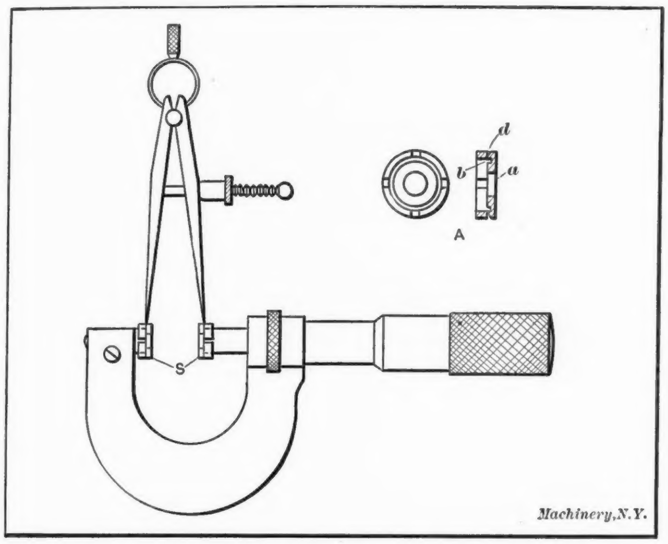
ture also makes an excellent inside angle-plate, it only being necessary to remove the sliding jaw.

The more common way, perhaps, of making tools of this class is to have the projecting base turn the other way; but the advantage in having the foot turn in under the work, as shown, is that when used on a faceplate, it does not overhang so much, thus doing away with much counterbalancing and allowing a smaller faceplate to be used.

Frankford, Pa. ROY PLAISTED.

MICROMETER ATTACHMENTS FOR SETTING DIVIDERS

One is sometimes confronted with the task of setting the dividers or trammels accurately when laying out work, such as jigs, dies, etc. If a vernier with facilities for setting the dividers is not available, the attachments shown applied to a



The Way the Micrometer Attachments are used for Setting Dividers

micrometer in the accompanying engraving will be found very useful, as the dividers can be set with them quite as accurately as when the vernier is used. This is, of course, assuming that the attachments are made accurately.

As the illustration shows, these attachments consist of two sleeves *S*, one of which is fitted to the anvil of the micrometer and the other to the end of the spindle. An enlarged view of one of these sleeves is shown at *A*. A central hole *a* is drilled in the center of the sleeve so that it will be easy to see whether or not it is in contact with the anvil or spindle. Either four or six slots are sawed in the flange to insure a snug fit, and the corner is cut away, as at *b*, so that the inner surface will have a good bearing against the spindle or anvil. A groove *d* is cut in the outside, exactly in line with the inner surface, and into this groove the divider points are inserted when they are being set.

These sleeves are made in the following manner: A piece of tool steel about 1/16 inch larger in diameter than the anvil or spindle of the micrometer, is caught in the chuck and turned true on the outside, after which a central hole is drilled deep enough for the two sleeves. The end of the piece is then bored to a snug fit for the micrometer anvil or spindle, and a recess *b* is turned as shown in the sectional view at *A*. The first sleeve is then cut off, after which the second one is machined in the same way. The cutting of the V-groove *d* is the next and the most important operation. In order to cut this groove exactly in line with the inner surface of the sleeve, a piece is first turned to the same diameter as the anvil or spindle. After the end of this piece is faced square, the lathe carriage and turning tool are left undisturbed. The sleeve is then inserted over the end of the turned rod. By the use of a flat center in the tailstock, this sleeve is held firmly against the squared end of the rod while the V-groove is turned, with the tool set just as it was after the finishing cut was taken over the end of the rod. A depth of about 0.005 inch is sufficient for this groove. Slots are next cut in the sleeves in four or six places so that they may be sprung into place. The sleeves are then hardened and drawn to a blue color.

When turning the groove, and also when turning and facing the rod on which the sleeve is held, care should be taken to see that there is no lateral motion in the spindle of the lathe, as otherwise the tailstock center, when it is brought up against the work, will cause the groove to be out of alignment with the surface on the inside of the sleeve. L. E. KRAMER.

Newark, N. J.

SOLDERS FOR VARIOUS METALS

Soldering is divided into two classes, namely, hard and soft soldering. Ordinarily soldering with a heated copper bit employs "soft solders"—alloys of tin, lead, etc., which melt at comparatively low heats. The use of the blowpipe makes possible the employment of "hard solders" which are alloys of silver, copper, zinc, etc., and melt at a very much higher temperature than the soft solders. The hard soldering of copper, iron, etc., is generally known as brazing, and the solder as spelter. It must be borne in mind that both soft and hard solders deteriorate with age, if kept for a long time in a damp atmosphere. For electrical work, ingredients

SOFT AND HARD SOLDERS FOR VARIOUS METALS

Metal to be Soldered	Flux	Soft Solder		
		Tin	Lead	Other Constituents
Aluminum	Stearin	70	....	Z*25 A* 3 P* 2
Brass	Chloride of zinc,	66	34	....
Gunmetal	rosin, or chloride	63	37	....
Copper	of ammonia	60	40	....
Lead	Tallow or rosin	33	67	....
Block tin	Chloride of zinc	99	1	....
Tinned steel	Chlor. of zinc or rosin	64	36	....
Galvanized steel	Hydrochloric acid	58	42	....
Zinc	Hydrochloric acid	55	45	....
Pewter	Gallipoli oil	25	25	B*50
Iron and steel	Chloride of ammonia	50	50	....
Gold	Chloride of zinc	67	33	....
Silver	Chloride of zinc	67	33	....
Bismuth	Chloride of zinc	33	33	B 34

* Z = zinc A = aluminum P = phosphor tin B = bismuth

Metal to be Soldered	Flux	Hard Solder			
		Copper	Zinc	Silver	Gold
Brass, soft	Borax	22	78	......	......
Brass, hard	Borax	45	55	......	......
Copper	Borax	50	50	......	......
Gold	Borax	22	......	11	67
Silver	Borax	20	10	70	......
Cast iron	Cuprous oxide	55	45	......	......
Iron and steel	Borax	64	36	......	......

such as mixtures of vaseline, rosin, glycerine and chloride of zinc are used as non-corrosive fluxes. The accompanying table gives the composition of both soft and hard solders that are suitable for various metals. A. EYLES.

Manchester, Eng.

MACHINE CATALOGUE COVERS

A common fault with machine catalogues is that while they state just how many accessories are provided, and that this part and that are casehardened, and the other is bronze-bushed, etc., they omit to say how the machines operate and how much work of a given kind they will turn out per hour. Further, some of them do not bear on the cover the maker's name, or even that of the machine described.

How shall I index a catalogue "The Truth about Thingummies" or "The People's Verdict?" ROBERT GRIMSHAW.

Dresden, Germany.

* * *

Manufacturers interested in the International Exposition to be held at Turin, Italy, in 1911 can obtain further information relating to the exposition from the Italian Chamber of Commerce of New York, which has been appointed as the local committee for the United States.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

TINNING STEEL PANS

G. S.—I have about 1,000 steel pans 12 inches long, 8 inches wide, 2 inches high, 1/64 inch thick, to tin. What is the easiest and cheapest method of obtaining a heavy tin coating? The pans are unpolished.

A.—The question is referred to our readers for answer. It is desired that the responses refer to methods of tinning that are practicable to follow in a plant not equipped with tin dipping facilities.

PROPORTIONS OF AUTOMOBILE PISTON RINGS

H. B.—What are the proper proportions of automobile cylinder piston rings? How do they compare with the proportions of gas-engine rings used by the leading gas-engine builders? How much smaller than the bore should a gas-engine piston be turned to secure the best results? We have found that the accepted proportions for steam engine cylinder rings make rings too stiff for gas-engine use.

A.—These questions are submitted to the readers for discussion.

FINISH ON IRON CASTINGS

E. S. S.—1. I have a few castings that I wish to paint and secure a glossy enamel finish. What is the best method to obtain this finish? Could it be done without baking on? I want a finish that will not crack and lose its gloss in a few weeks. 2. Why do gray or streaked spots work through the oxidized finish on malleable iron castings? Is there any way to prevent it? The spots do not show on steel. Is it the fault of poor oxidizing?

A.—These questions are referred to our readers for answer.

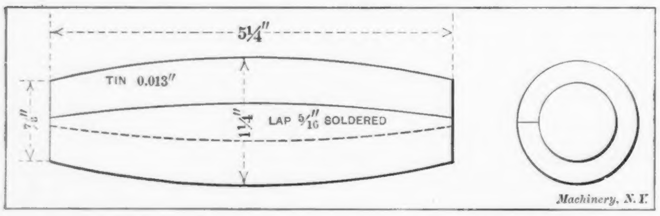
HOW TO BEND TAPERED BRASS TUBES

E. P. D.—I would like to know the best method of bending tapered tubes for automobile horns. The tubes are 9 inches long, 1⅛ inch and ¾ inch diameter at the large and small ends, respectively. The tubes must be bent U-shape, the radius of the inside curve being 1½ inch. The metal is brass, 0.025 inch thick.

A.—Thin brass tubes may be bent without crushing or wrinkling by first filling them with melted rosin or melted sulphur. The bending should be done over a hardwood former shaped to the arc of the curve desired, but as a commercial process for bending tubes in large quantities this method is too slow. Descriptions of improved methods of bending tapered brass tubes are invited from our readers.

HOW ARE COFFIN HANDLES MADE?

R. S. B.—How is the coffin handle shown in the sketch made? It is of tin 0.013 inch thick, with seam lapped about



5/16, and soldered. The work shows very slight evidence of wrinkling, and if made in the press is a very good job.

A.—The question is submitted to the readers of MACHINERY for reply. A contribution describing the tools used for making this or similar pieces will be acceptable.

TO OBTAIN THE HEIGHT OF A SEGMENT WHEN THE AREA IS GIVEN

J. W. H.—How is the height of a segment found that contains one-third the area of a circle 4 inches diameter?

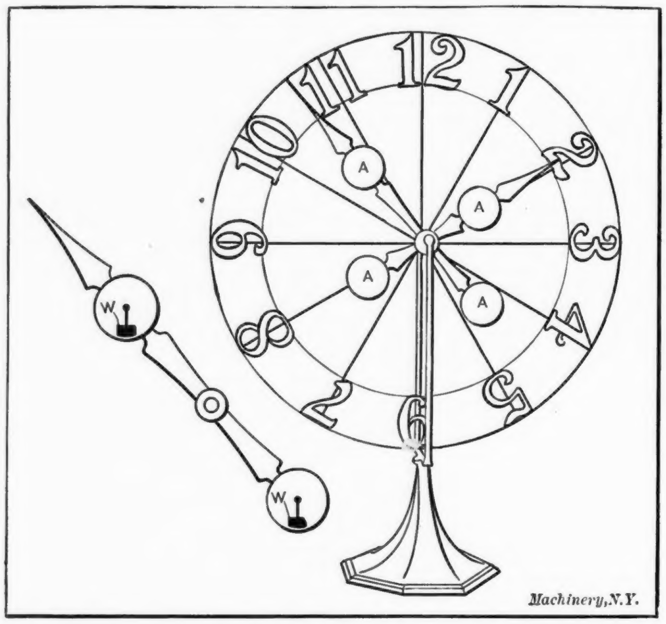
A.—Although the calculation of the area of a segment is comparatively simple, using the approximate formula

$$A = \frac{4h^2}{3}\sqrt{\frac{D}{h} - 0.608}$$

the converse proposition is more difficult, as there is no simple formula for finding the height or the chord of a segment when the area and diameter of the circle are given. Recourse must be made to tables of segment areas found in engineers' hand-books. The procedure in this case is as follows: First find the area of a segment that contains one-third the area of a circle having a diameter 1 inch. $1^2 \times 0.7854 = 0.7854$ square inch; $0.7854 \times 1/3 = 0.2618$ square inch, area of segment. Reference to a table of segments shows the height of the middle ordinate to be 0.3675 inch. The height of the corresponding segment of a circle 4 inches diameter is $0.3675 \times 4 = 1.5000$ inch, the required result. This is one of the several problems involving areas of segments, lengths of elliptic arcs, areas of zones, etc., that can be solved by ordinary mathematical processes only by reference to tables.

A CLOCK WITHOUT WORKS?

O. A. A.—What appears to be a most wonderful clock has recently come under my observation, and I would like to have the principle of its action explained. This clock is apparently without works, but it records the time accurately, and when the hands, which are easily moved in either direction, are



spun on their axes, they always come back to the correct position. The dial may also be whirled around, but even though the hands and the dial be set in motion simultaneously, they always come back to their correct relative positions.

A.—This clock is an interesting mechanism, but we believe that it is comparatively simple in its construction. The idea has been used for years in the construction of jewelers' clocks and other clocks where it is desired to attract attention. Usually the hands are made with large hubs in which the clock movements are located, and the hands are driven by the reaction of these movements against a counterweight within the hub. In the case of the clock referred to by our correspondent (see accompanying illustration), there are probably two movements for each hand, which are located in the cylindrical parts *A* and cause the rotation of the hand by reacting against counterweights. These counterweights *W* hang with their centers of gravity below the center of the clock mechanism, and as the hands are perfectly balanced, the action of the works is transmitted through the reaction of the counterweight to the hands, causing them to assume the hour and minute positions. Probably the action of the hands will be more easily understood if we assume that the weights *W* are being continually swung from their vertical position, to the right, thus shifting the hand's center of gravity and causing it to revolve. The two movements in each hand run in unison, the set for the hour hand being geared to revolve once in twelve hours while the minute hand revolves once in an hour. As this construction makes connection with the fixed support unnecessary, the hands, when spun around on their axes, will always come back to the correct position which is determined by the relative positions of the counterweights to the hands in which they are suspended. The dial is easily

made to finally stop in the correct position after it has been spun around, by adding a little additional weight to the bottom, thus throwing it out of balance.

MUTILATION OF U. S. COINS

W. H.—In the December, 1906, number of MACHINERY W. L. McL. described the making of a pretty stick-pin by filing out the profile of the head on a dime. I would like to know if the law regarding the mutilation of coins would apply to this case. If I make a pin in this way am I liable to prosecution?

A.—Technically the making of a stick-pin from a United States coin in the manner described is a violation of section 5459 of the revised statutes. Any defacement or mutilation of gold and silver coins short of complete destruction of the coin or change in shape which will make it impossible for it to circulate as money is, in the opinion of the chief law officer of the treasury department, illegal. It is not likely that an individual who merely makes an ornament for himself or a friend in the manner described would be prosecuted, especially if it were gold-plated afterwards, but anyone *manufacturing* ornaments from mutilated coins probably would get into serious trouble. The chief of the Secret Service informs us that jewelers who make a practice of transforming gold and silver coins into articles of jewelry usually fit a band of like metal around the coin and make any necessary attachments to that band rather than to the coin itself. In this way the coin is preserved in perfect condition, and there is not even a technical violation of the statute.

TO OBTAIN AN ANGLE BY COMBINING THE FEEDS OF A BORING MILL

H. N. K.—To what angle must I set a boring mill head to turn a taper at an angle of 45 degrees with the base when using both feeds in combination. The cross-feed screw is four threads per inch or ¼ inch feed for one turn of the handle, and the down feed is 3/16 inch for one turn of the handle. The pinions on the feed shafts have the same number of

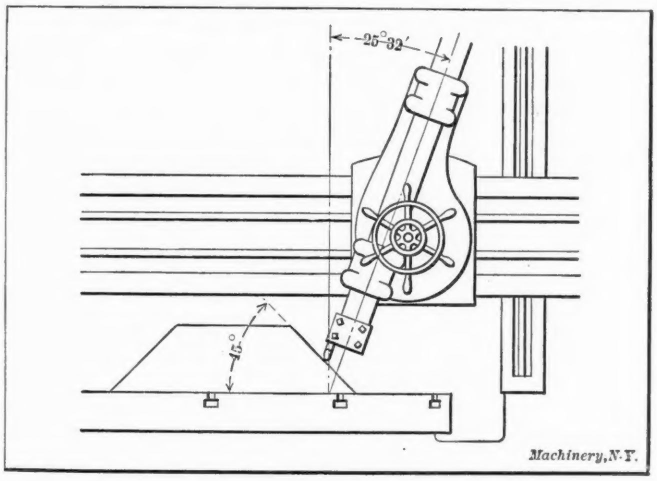


Fig. 1

teeth, and the ratio of feeds, therefore, is as 3/16 to 1/4. I would like to know if there is a method, table or formula for obtaining any desired angle with combined feeds.

A.—The angle can be found graphically in the following construction Fig. 2: Draw the horizontal line AB to represent the boring mill table and the line CD at an angle of 45 degrees, representing the angle to be produced. Now we require to strike two arcs with radii in the proportion of 3/16 to 1/4. To secure the desired accuracy, it is desirable to use longer radii, and we multiply 3/16 and 1/4 by, say, 32, giving as results 6 and 8 inches. With the dividers set at 8 inches, strike an arc from D as a center intersecting AB at E. With E as a center and with a radius of 6 inches, strike another arc intersecting CD at F. Then FEG, the angle made with the vertical EG, is the required angle to which the head should be set. The angle measured with a protractor is 25½ degrees. The method of solving when DEF is less than 90 degrees is:

$$\sin EFD = \frac{H_f \times \sin EDF}{V_f}$$

in which

H_f = horizontal feed,
V_f = vertical feed,
EDF = angle required on work,
FEG = angle to which the head must be set to produce angle EDF,

$$\sin EFD = \frac{1/4 \times 0.7071}{3/16} = 0.9428.$$

$$\text{Angle } FEG = (EFD + EDF) - 90$$

The angle whose sine is 0.9428 is found in a table of sines to be 70 degrees 32 minutes. Angle EDF = 45 degrees. Then

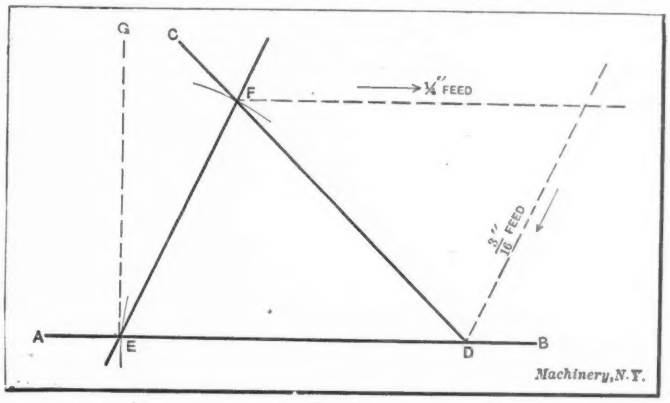


Fig. 2

angle GEF = (70 degrees 32 minutes + 45 degrees) — 90 degrees = 25 degrees 32 minutes. The same methods may be used for finding the angles produced by combined vertical and horizontal planer feeds.

* * *

FORMULAS FOR CALCULATING A FRICTION DISK BRAKE*

JOHN WILL†

In the following article will be given a set of formulas for calculations relating to the well-known mechanical brake used on electric hoists. A diagrammatical sketch of such a brake is shown in Fig. 1. An example illustrating the use of the formulas given will also be worked out.

The object of the brake shown is to permit the lowering of the load at a constant speed with the power reversed, and the holding of the load suspended when the current in the motor is shut off. When the load is lowered it rotates, by means of the drum and gearing, the flange D against the ratchet disk H; the flange D is mounted as a nut on the screw A; the flange C is keyed to the shaft as shown. The pawl engaging with the ratchet disk does not permit it to rotate when the load is lowered. As the ratchet disk thus is stationary, the work of the motor and of the lowered load must equal the work absorbed by the friction surfaces in the brake. When hoisting, the motor rotates the flange D against the nut E so that then there is no pressure on the friction disks; the motor is thus free to hoist the load without any frictional resistance.

The amount of opening between the friction disks should be as small as possible, and the number of teeth in the ratchet disk as great as possible, consistent with required strength. In this way excessive pressure on the ratchet teeth, due to the sudden dropping of the load when the current in the motor is shut off after hoisting, may be avoided. The drop of the load, of course, is proportional to the opening between the friction disks, and the amount the pawl allows the ratchet disk to rotate before engaging a tooth and stopping it positively.

The action of the load and the motor on the brake may be explained by a simple illustration. In Fig. 2 the bar A is shown resting on two wedges B between the walls C. The load P is a constant pressure acting downward on the bar A. This pressure, however, is not great enough to overcome the frictional resistance between the wedges B and the walls C. If an additional downward pressure P_1 is put on the wedges, so that the combined pressures P and P_1 equal or exceed the frictional resistance, then the bar and the wedges will slide

* Answer to an inquiry in the How and Why department, January, 1905.
† Address: 180 South 11th St., Newark, N. J.

downward as a whole. In the mechanical brake in Fig. 1 the load on the hook may be considered as the pressure P in Fig. 2. The pressure P_1 may be assumed to be the effort exerted by the motor in order to lower the load.

In the formulas following, the notation below will be used:

E = energy absorbed by friction disks in foot-pounds per minute,
E_1 = energy of the lowered load in foot-pounds,
E_2 = energy of the motor in foot-pounds,
e_1 = total efficiency of mechanism between load and flange D, Fig. 1,
e_2 = total efficiency of the mechanism between the motor and flange C, Fig. 1.
T = torque in inch-pounds on pinion F,
r = mean radius of screw in inches,
r_1 = inside radius of friction disks in inches,
r_2 = outside radius of friction disks in inches,
n = number of friction surfaces,
N = number of revolutions per minute of flanges C and D,
A = area of each friction disk in square inches,
W = total pressure in pounds on friction disk,
f = coefficient of friction between the flanges and the friction disks,
P = lead of the screw in inches,
ϕ = angle of repose of screw in degrees,
α = helix angle of the thread of screw in degrees,
y = number of thermal units of heat conducted away per square inch of bearing surface per minute; y may be considered to be from 4 to 7, when the mechanism is exposed to a current of cold air and in intermittent service, and as equal to 0.75 to 1 in tolerably cool places with intermittent service.

When a sufficient number of quantities are known, energy absorbed by friction, the pressure on the disks and the lead P of the screw in the brake may be found by the following formulas:

$$E = E_1 e_1 + E_2 e_2 \qquad (1)$$

$$E = 0.349\, n\, f\, W\, N \frac{r_2^3 - r_1^3}{r_2^2 - r_1^2} \qquad (2)$$

$$W = \frac{T}{r \tan(\alpha + \phi)} \qquad (3)$$

$$P = 2\,\pi\, r \tan \alpha \qquad (4)$$

$$y = \frac{E}{778 \times 2\,A} \qquad (5)$$

[Formula (2) is based on the theoretical assumption that

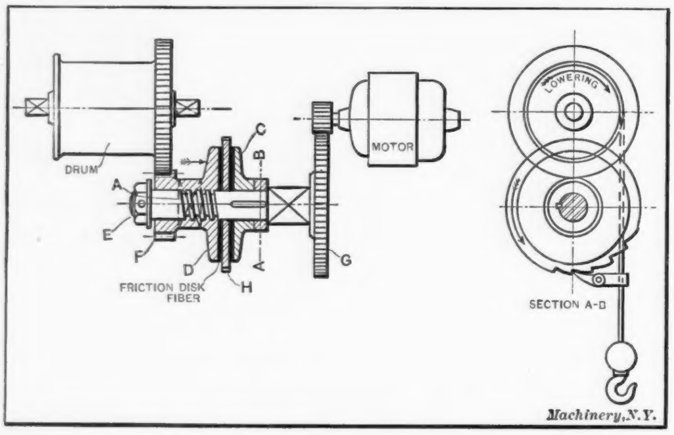


Fig. 1

the mean radius at the end of which the resultant of the frictional forces may be considered as applied, equals

$$\frac{2}{3} \times \frac{r_2^3 - r_1^3}{r_2^2 - r_1^2}$$

thus taking the radius to the center of gravity of the small trapezoids into which the annular ring may be supposed to be divided. Although this is correct both theoretically and practically when the brake is new and the pressure distributed uniformly over the entire surface, the disk wears faster on the outside edges than on the inside, resulting ultimately in greater pressures at the inner edge, and it has been found that a formula considering the mean radius as the arithmetical mean between the outside and inside radii gives better results for working conditions.—EDITOR.]

Example:—Assume that we have the following data: At 230 volts and a speed of 1,000 revolutions per minute, 25 amperes are required for hoisting the load. At a speed of 1,500 revolutions per minute, 9 amperes are required for lowering the load. The motor efficiency is 80 per cent, the drum is 12 inches in diameter, the drum gear ratio is 1 to 7, and the motor gear ratio is 6 to 1. The efficiency of each set of gearing is 90 per cent. The outside radius of the friction disks is 7 inches, the inside radius 3 inches, and the mean radius of the screw, 1¼ inch. The number of friction disks is 2, as shown in Fig. 1, the number of revolutions of the friction disks is 1,500 ÷ 6 = 250, the coefficient of friction between the flanges and the friction disks is 0.07, and the angle of repose of the screw, 8 degrees 30 minutes. From this data we find that the maximum load of 2,200 pounds may be hoisted at a speed of 75 feet per minute and lowered at a speed of 112.5 feet per minute, as follows:

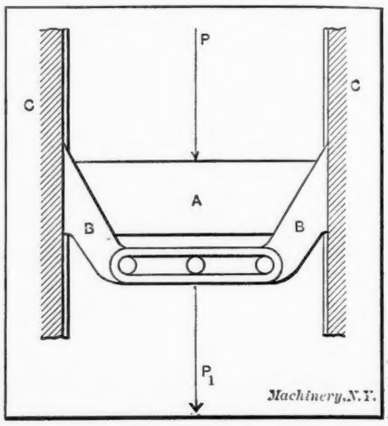


Fig. 2

$$\frac{1{,}000 \times 12 \times 3.14}{6 \times 7 \times 12} = 75 \text{ (hoisting speed)},$$

$$75 \times 1.5 = 112.5 \text{ (lowering speed)},$$

$$\frac{230 \times 25 \times 44.2 \times 80 \times 90 \times 90}{75 \times 100 \times 100 \times 100} = 2{,}200 \text{ pounds, nearly.}$$

We will now find the lead P of a screw which will give a lowering speed of 112.5 feet per minute with the given conditions.

$$E_1 e_1 = 2{,}200 \times 0.90 \times 112.5 = 222{,}750 \text{ foot-pounds.}$$

$$E_2 e_2 = 230 \times 9 \times 44.2 \times 0.90 \times 0.80 = 65{,}900 \text{ foot-pounds.}$$

From formula (1):

$$E = E_1 e_1 + E_2 e_2 = 222{,}750 + 65{,}900 = 288{,}650 \text{ foot-pounds.}$$

From formula (2):

$$W = \frac{E}{0.349\, n\, f\, N \dfrac{r_2^3 - r_1^3}{r_2^2 - r_1^2}} = \frac{288{,}650}{0.349 \times 2 \times 0.07 \times 250 \times 7.9} =$$

3,000, approximately.

From formula (3):

$$\tan(\alpha + \phi) = \frac{T}{W r} = \frac{[(2{,}200 \times 6) \div 7] \times 0.90}{3{,}000 \times 1.25} = 0.453.$$

Hence, $\alpha + \phi = 24° \, 20'$, and $\alpha = 24° \, 20' - 8° \, 30' = 15° \, 50'$.

From formula (4):

$$P = 2 \times 3.14 \times 1.25 \times \tan 15° \, 50' = 2.23 \text{ inches.}$$

This gives a screw of practically 2¼-inch lead. If a double thread is used the pitch will be 1⅛ inch.

From formula (5):

$$y = \frac{288{,}650}{778 \times 2 \times 125.6} = 1.48,$$

which would be satisfactory when the brake is well exposed to the air.

The maximum allowable pressure per square inch on the friction disks should be limited to 200 pounds. In the example above we find that the pressure equals

$$\frac{W}{A} = \frac{3{,}000}{125.6} = 24 \text{ pounds per square inch, approximately.}$$

* * *

Don't start a piece of work until you have measured and examined the stock to see if it is correct for size and kind.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

MILWAUKEE PLAIN MILLING MACHINE

In the department of New Machinery and Tools in the August, 1908, issue of MACHINERY was described the No. 3B Milwaukee universal milling machine, made by the Kearney & Trecker Co., of Milwaukee, Wis. The same general lines of design followed in that machine have now been applied by the makers to their plain milling machine, which is here described and illustrated, with the changes permitted by the absence of the swivel carriage for the table. In connection with this plain design of machine, we are able to show a number of details of the very interesting driving and feed mechanism employed.

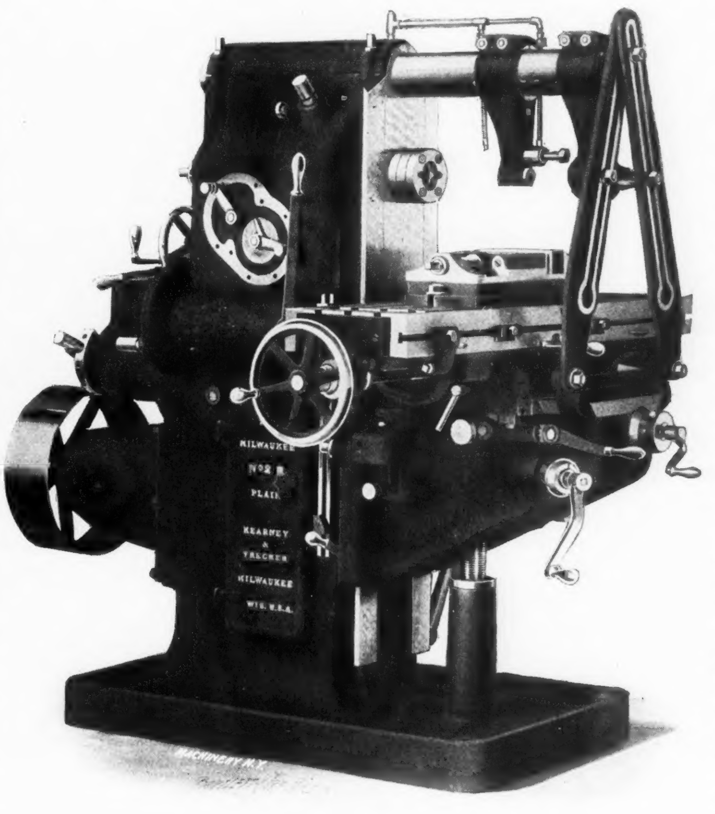


Fig. 1. Milwaukee No. 2 B Plain Milling Machine, with Geared Drive and Feed

The main features of this line of machines are the geared feed and speed changes, the provision for continuous lubrication from an oil reservoir, and the permanent arrangements incorporated in the machine for supplying lard oil or other compound to the cutting edges of the mill. In connection with the first point, it will be remembered that the makers of this machine built it with geared drive only, their confidence in this construction being such that they have entirely abandoned the cone pulley, and do not employ it in any size or style of their products.

Structural Features

Rigidity in the framework is a fundamental requirement for an accurate and productive tool. In this machine the column is cast in one piece, with strong internal ribs. It has a box section, with as few and as small openings as possible, and it increases in depth as it extends downward toward the pan-shaped base. This latter is sufficiently high to leave room for heavy ribbing, which makes masonry and cement foundations unnecessary where the floor is strong enough to carry the load. The sliding surfaces for the knee extend clear to the top of the column around the spindle box, thus giving the needed additional metal at this point. The upward extension of the slide serves also as a convenient means of fastening the various attachments, which thus become practically an integral part of the machine, and capable of very severe service.

The knee is of the enclosed box form, with as few openings as possible, none being permitted in the upper surface. This is important as it obviates all danger of the closing together of the surfaces under the strain of clamping the saddle. It also obviates the necessity of a sliding cover to keep chips out of the knee mechanism. A long bearing is provided for the knee on the column, extending up above the saddle bearing.

The over-arm is a solid steel bar, located with great accuracy parallel to the spindle. The arbor supports are firmly clamped to this. The arm braces have been especially designed with regard to convenience in handling, there being no single piece too heavy for one man to adjust with ease. Throughout the structural design metal has been added with the single purpose of securing strength and ridigity; it has not been placed here and there in a haphazard way, merely for the purpose of getting a high total weight for selling purposes.

Spindle Driving Mechanism

The arrangement of the drive is best shown in the vertical section through the column, Fig. 2, in connection with the small details in Figs. 3 and 5. The driving pulley *A* runs at constant speed in one direction, there being no necessity for cone pulleys or a reverse clutch in the countershaft. The shaft on which it is mounted carries an integral pinion meshing with gear *B*, which is loose on the shaft above it. The hub of this gear carries a steel jaw clutch engaging a similar clutch on the face of gear *C*, which is keyed to the shaft. *B* is shifted longitudinally to engage, or disengage the clutch connection by means of the vertical hand lever shown on the left side of the column in Fig. 1. Gear *C* meshes with *D*, which, in turn, may be connected with constant speed shaft *E*, either directly or through the medium of idler gears *F*. The shifting of pinion *G* by handle *H* governs this connection, and thus reverses the spindle.

In transmitting the motion from shaft *E* to *J*, six changes of speed are provided for by an interesting modification of the tumbler gear type of speed change mechanism. In this case a compound tumbler gear *K* having three steps, is used as shown. This meshes with the keyed sliding gear *L* on shaft *E*, and is carried by the swinging frame *M*. Either one of the three steps of gear *K* can be made to engage with either of gears *N* or *O* on shaft *J*, thus giving the six changes of speed.

The solid support given to the sliding gear *K* should be noted. It revolves on a hardened steel stud, firmly fastened in the steel frame. This latter is securely supported on both sides of the tumbler—on one side by shaft *E* which is, for this purpose, made much larger than would otherwise be required; and on the other side by the teeth of the long pinion *P*. This latter is rocked by handle *Q* to raise or lower the tumblers into proper position to mesh with the gear *N* or *O*. The shifting of the tumbler lengthwise is effected by the lower swinging handle on the front of the frame in Fig. 1, operating through the segmental gear and rack shown at *R* in Fig. 4.

Three additional changes of speed are effected by sliding gear *S*, which may be shifted to the rear so that its small diameter engages with gear *O*, or it may be set in a central position where its larger diameter, as shown in Fig. 2, engages gear *N* on shaft *J*. Moving it still further to the right clutches it, by means of the driving pin shown, to the large gear *T*, which runs loosely on the spindle, driven by a pinion on shaft *J*. Eighteen changes of speed are thus provided for through a mechanism which is strong and direct.

The feed change mechanism is identical in principle with that provided for the spindle changes. Twelve rates of feed are provided for, controlled by convenient levers and indicated by an indexing plate. The feed is driven directly from the shaft on which gear *D* is mounted, so that it is driven at a

constant rate, giving definite feeds in inches per minute. This construction has become standard for efficient milling machine design, since it permits all the feed changes to be practically applicable to any speed, and thus allows a greater number of effective changes for the whole range of speeds, from that required for small mills on soft metals, down to the heaviest work the machine is capable of.

In any geared feed and speed mechanism the efficiency and durability of the gearing, bearings, etc., is largely dependent on the care with which they are lubricated. In this machine a reservoir of machine oil is provided from which a stream is kept constantly flowing whenever the driving pulley is in motion, over all the gears and into all the journals. These journals are provided with oil grooves open at the ends to permit a constant and rapid flow, thus keeping them constantly cool and flushed of foreign matter. This point in the design of these machines is so well known that it is not necessary to expatiate on it further.

For holding the spindle in inserting or removing cutters, etc., or for using fly cutters, a stop is provided which engages the teeth of large gear T. This engagement extends over several of the teeth, which it fits accurately. It thus holds the spindle without play and without danger of breakage. For turning the spindle through small fractions of a revolution, a handwheel is provided at the rear end of shaft J as shown. This makes possible more delicate adjustment than can be obtained even on the belt-driven machine. A knock-out for arbors and taper shank mills is permanently mounted in the machine. Large face mills are driven by a key and keyway set into the front face of the spindle. They are clamped in place by four screws passing through the mill into the spindle flange. This arrangement is preferable to the thread usually provided for the purpose, since this thread, if too fine, permits the cutters to jam in place under the strain of a heavy cut, and makes it difficult to remove them; while, if the lead be made steeper, there is a constant tendency to work loose.

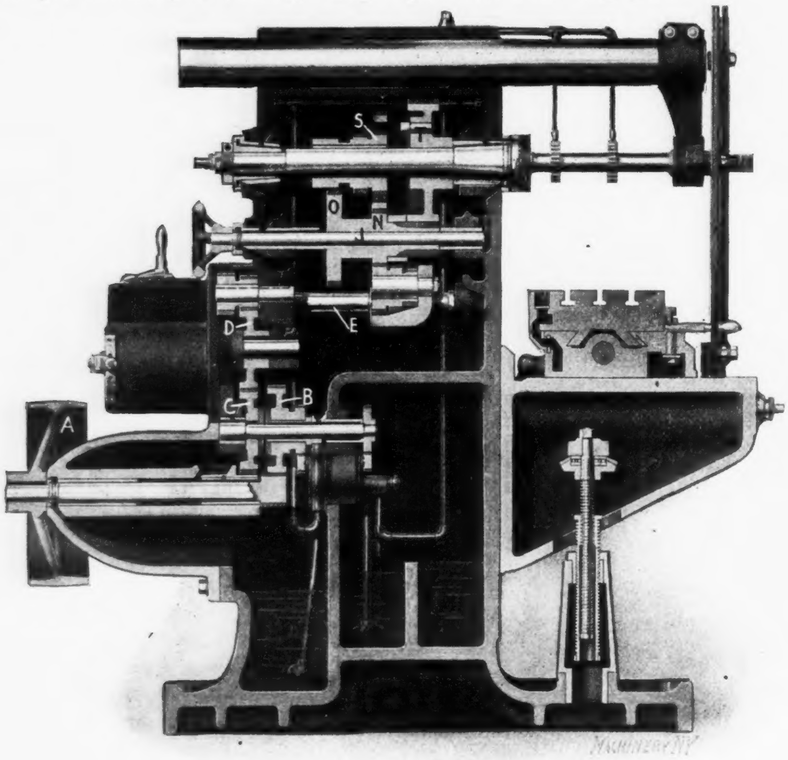


Fig. 2. Section through Column, showing Spindle Drive

Details of the Feed Control

Another detail of the machine is seen in Fig. 4, which shows a vertical section through the knee, exposing the mechanism by which the table cross and vertical feeds are interlocked with each other so that no two can be engaged simultaneously. The telescopic shaft from the feed box leads to gear U, from which, through the intermediate gearing and clutch shown, the motion is transmitted to gear V. The clutch W serves to reverse the feed for movements in all directions.

Gear V gives movement to any one of three shafts, X, Y and Z. X is for the table feed, Y for the cross-feed and Z for the vertical movement. As shown in the engraving, with lever A_1 in the central position, clutch X is engaged, and consequently the table feed gearing is in motion. Whether the feed is in actual operation or not depends, of course, on whether the feed handle at the front of the table is thrown in. Now in order to have the plunger of lever A_1 enter the hole provided for it in the central position, it must pass through a hole in lever B_1 which must consequently also be in its central position. B_1 controls the clutches at Y and Z, respectively, which thus are always disengaged whenever the clutch at X is thrown in.

Lever B_1 and the clutches with which it is connected are operated by a lever at the front of the saddle, which thus serves to throw in or out the vertical and cross movements, respectively. Since these movements are locked, as explained, when the table feed is engaged, it is necessary before using either of them to disengage that feed. This is done by throwing lever A_1 to either one side or the other (depending on whether cross or vertical movement is desired) and locking it in this position. Lever B_1 and the clutches with which it is engaged are thus free to swing from the central or off position to one side or the other under the influence of the lever at the front of the saddle. It is thus possible to use this lever for throwing in or out either the vertical or the cross feed, depending on which side of the center lever A_1 is located.

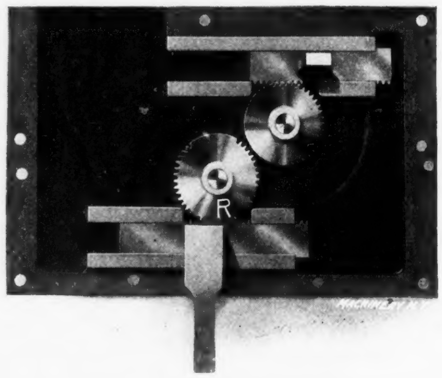


Fig. 3. Spindle Change Gear Controlling Mechanism

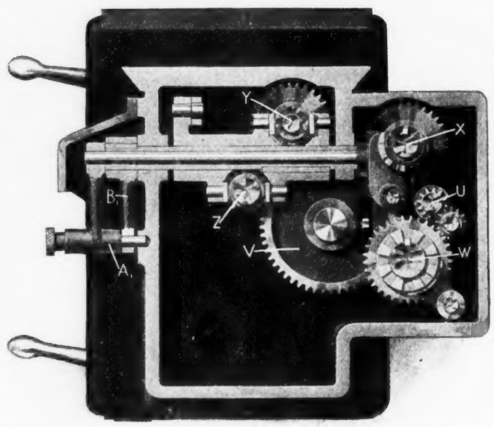


Fig. 4. Interlocking Feed Control in Knee

Fig. 2 shows the two sets of oil reservoirs and pumps supplied. The pump in the double front compartment forces a constant supply of cooling fluid over the cutters through piping regularly provided. Chip channels are formed in the table and a jointed pipe drain connection leads the lubricant back into the settling chamber again, so that a constant stream is provided to cool the cutters. This gives better finish, allows heavier cuts, and prolongs the life of the cutting edges of the tools. This useful provision is regularly furnished and does not have to be specially specified.

General Design

It will be seen that these machines are designed with the idea of providing for ample spindle power, for rigidity suffi-

cient to permit the highest output of any cutter that may be used, and for the accuracy required for interchangeable manufacturing. The convenience of the changes also adds highly to the productive capacity. Besides the universal type previously illustrated and the plain machine here described, the builders furnish this tool in a simplified form which they call their manufacturing machine. This retains the same features of feed and speed change and the same general construction throughout, but has a simpler feed mechanism in the knee and saddle, the power feed being applied only to the longitudinal table movement.

The bracket on which the constant speed driving pulley *A* in Fig. 2 is mounted is interchangeable with two other styles, so that any machine may be fitted up as required by the customer. One of these alternative forms gives a right angle constant speed pulley drive, for use where the line shaft and floor arrangements make this style preferable. The third style of bracket provides for the mounting of a constant-speed motor of any standard commercial type. It should preferably be of 5 horsepower, and capable of carrying 50 per cent overload for an hour without danger. The three systems of drive can be interchanged with each other at any time, without special preparation or changes in the machine.

The following dimensions refer to the No. 2B plain milling

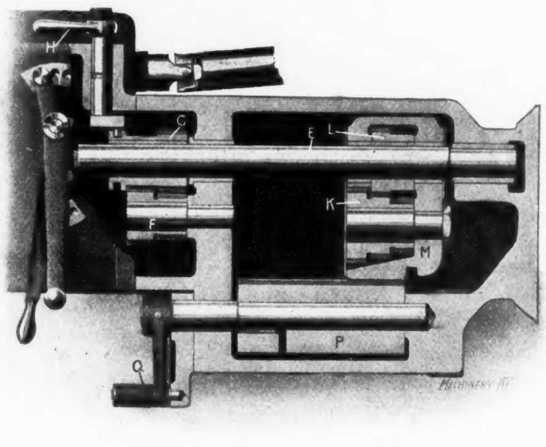


Fig. 5. Design of Tumbler Gearing for Spindle Drive

machine. The driving pulley is 16 inches in diameter for the 4½-inch table belt, and runs at 300 revolutions per minute. The spindle is of forged crucible steel, running in bronze bearings, adjustable for wear; it has a No. 11 Brown & Sharpe taper hole. Eighteen spindle speeds are provided in geometrical progression, ranging from 15 to 360 revolutions per minute with a maximum gearing ratio of 20 to 1. The twelve feeds range from ½ to 60 inches per minute. The table has a working surface of 47 by 12 inches with three T-slots. A plain vise and all necessary wrenches are furnished with the machine. The net weight is about 3,900 pounds.

FUNK MACHINE CO.'S POSITIVE PRESSURE BLOWER

An interesting type of rotary blower has just been brought out by the Funk Machine Co., 23-27 City Hall Place, New York. This firm, which manufactures printing and book-binding machinery, designed this blower for use in connection with a feeding machine. When the blower was tested, it proved so efficient that it was decided to place it on the market. An exterior view of the blower is shown in Fig. 1, while Fig. 2 shows the interior mechanism which consists of only a suction and discharge valve, and a piston with the two impeller blades. The valves which are closely fitted between the outer cylinder and the piston or central drum, are driven from the main shaft by gearing, as indicated in Fig. 1. This gearing is so proportioned that each valve makes two revolutions to one of the main shaft. The valves are crescent shaped in cross-section, and have solid disks on each end. Each valve is so set in relation to the impeller blades that the crescent-shaped part, which extends the width of the cylinder, rolls over the end of each blade as it passes. The impellers may be rotated in either direction, as a change in the direction of their movement simply causes a corresponding change in the position of the suction and discharge outlets.

If we assume that the piston, when viewed from the side shown in Fig. 2, is given a counter clockwise movement, the action of the blower would be as follows: As one blade passes the lower, and what in this case would be the suction opening, the air is drawn in back of it, the valve just above this opening being closed. As this blade moves around toward the top of

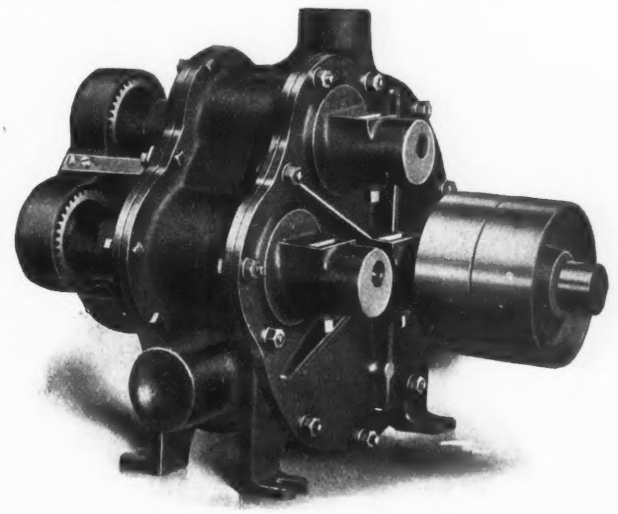


Fig. 1. Rotary Blower built by the Funk Machine Co.

the cylinder, this air is forced out through the discharge port by the following blade, as the space between the piston and cylinder is closed by the upper or discharge valve. When a blade is passing the discharge valve, the suction valve is closed, and remains so until the discharge valve has again moved around sufficiently to seal the space between the cylinder and the central drum or piston.

The impeller blades are of steel, and are firmly attached to the piston. Neither the blades nor the piston bear against the cylinder, but they are made with as little clearance as possible in order to reduce the friction to a minimum. An important point in the construction of this machine is that the friction remains practically constant as the discharge pressure increases. The valves are of bronze, as are also the pinions

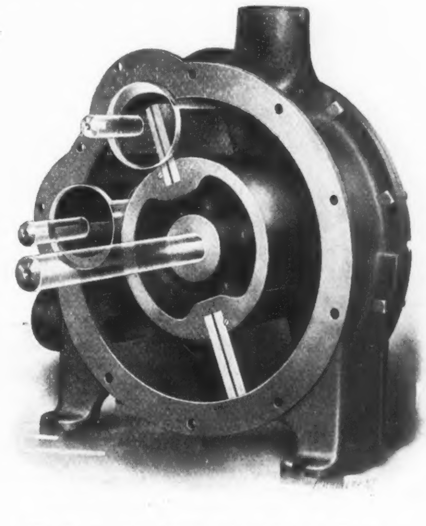


Fig. 2. Interior View of the Rotary Blower

by which they are driven. All bearings are self-oiling, and there are no parts that are likely to become deranged. These machines are built, at present, in three sizes, designated as Nos. 1, 2 and 3. The makers state that during a test run the smallest size delivered 45 cubic feet of air per minute, and maintained a pressure of 2 pounds against five openings ¼ inch in diameter, with a power consumption of 4/10 horsepower. The capacities of the two larger sizes are two and three times that of the smallest size, respectively. Obviously, this blower may be used either for exhausting or compressing air, or for both purposes simultaneously.

NEW LINE OF KELLY CRANK SHAPERS

A new line of crank shapers is now being manufactured by the R. A. Kelly Co., Xenia, O. In designing these shapers, one size of which we illustrate herewith, the company gave special attention to the proper distribution of the metal in order to have a machine with sufficient strength to resist the greatest working strains that are likely to be imposed on it by the use of high-speed steel. The question of strength in this connection, has not alone been considered, as the driving mechanism for each size is so proportioned as to give the greatest output within the limits of high-speed steel tools. This has been accomplished by using wide-faced, accurately-

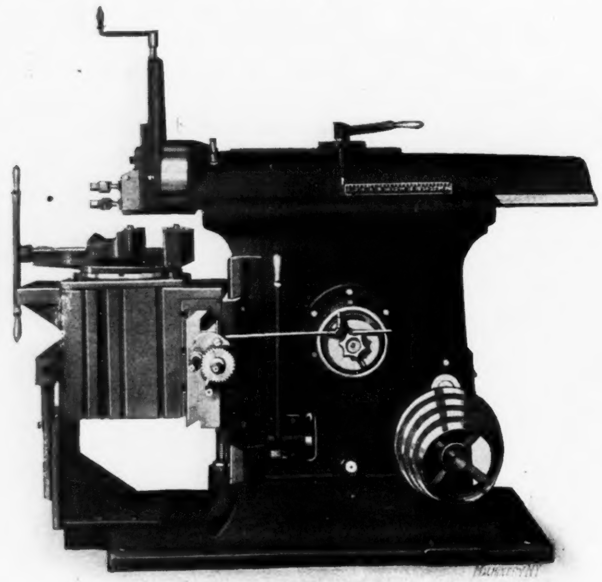


Fig. 1. New Design of Kelly Crank Shaper

cut gears, and employing high gear ratios, ranging from 24 to 1 to 33.2 to 1 in the 16- and 26-inch machines, respectively.

The arrangement of the driving mechanism is illustrated in Fig. 2. The drive is transmitted from a 4-step cone-pulley to the bull-wheel through either of two trains of gears, depending on the speed desired. By shifting the double-ended pinion *A*, which is free to slide on the driving shaft, to either of its extreme positions one of these trains is brought into action. The position of pinion *A* is changed by the vertical lever seen just back of the cross-rail in Fig. 1. It will be seen

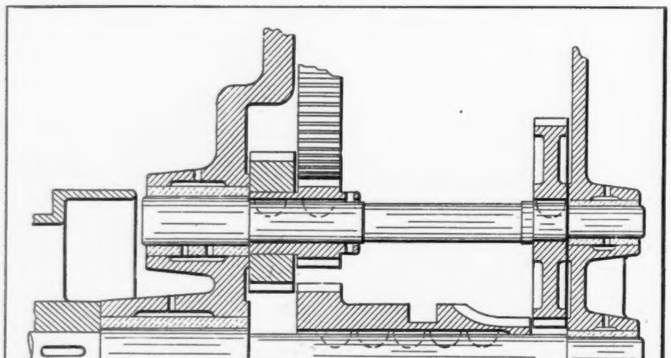


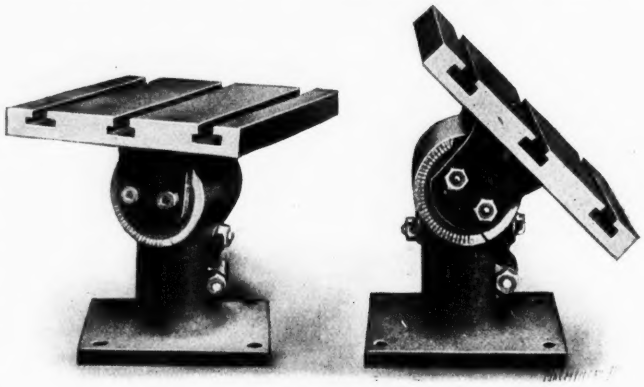
Fig. 2. Detail of the Driving Mechanism

then that the four cutting speeds obtainable from the four steps of the cone-pulley, may be doubled by this arrangement of back gears, giving eight speeds in all. The machine may, of course, be stopped by shifting the driving pinion to its neutral position between the gears with which it meshes.

The bases of these machines are very heavy, and are provided with internal ribs giving them great rigidity. The table, which is of box form, is rigidly supported at its outer end as the engraving indicates. All the bearings in the column are cast integral with it, and those on the larger machines are bored and bushed with Lumen metal. These bearings are of ample length, and all are provided with oil pockets that will hold enough lubricant for one week's steady work. All of the machines have power elevating screws which are so arranged that they can be used as a power down feed on a great deal of work that is ordinarily done on a shaper. Each screw is of the telescoping type, thus making it unnecessary to bore clearance holes in the floor. The stroke of the ram can be changed while the machine is in motion or at rest, and a suitable scale indicates what the stroke is. A study of the machine illustrated, indicates that considerable thought has been given in the design, to the convenience of the operator. This is, of course, an important feature, as the efficiency of a tool of this kind, which is usually employed on a great variety of work, depends largely on the ease and convenience with which various changes, incident to the operation of the machine, can be made. Any of these machines will be arranged for electric drive if desired. The makers are also prepared to furnish any shaper attachments such as index centers, concave attachment, moldmakers' vise, etc., which may be wanted.

WILLIAMSON UNIVERSAL MACHINE TABLE

A new style of universal drill press table or angle-plate is now being made by the Williamson Vise Co., Bradford, Pa. Formerly the shank of this table was clamped to the table-arm of the drill press, the regular table being removed. The new design, which is illustrated herewith, is provided with an in-



Views illustrating the Movements of the Williamson Universal Table

dependent base which makes special changes, incident to its use, unnecessary. This table may be supported either on the regular platen, or on the machine base for large and heavy work. As the engraving indicates, the table may either be rotated in a horizontal plane or swung about its bearing to any desired position from the horizontal to the vertical. The angle for any position is indicated by suitable graduations. These tables are made in six different sizes: The platen of the smallest is six inches square, and its height, when in a horizontal position, is eight inches. The corresponding dimensions of the largest size are 30 and 41 inches, respectively. The usefulness of such a tool in a shop is so obvious that further comment is unnecessary.

SPRINGFIELD 36-INCH MOTOR-DRIVEN LATHE

Among the firms to recognize the superiority of the electric drive for machine tools, may be mentioned the Springfield Machine Tool Co., 631 Southern Ave., Springfield, O. This firm has given particular attention to the design and arrangement of the electrically-driven engine lathes which it manufactures. One of the heavy lathes built by this company, which has recently been equipped with a motor drive, is illustrated herewith. This machine has a swing of 37 inches over the bed and 24 inches over the carriage. The driving motor is of 7½ horsepower and it has a speed range varying between

600 and 1 200 revolutions per minute. Special attention has been given to the design of the headstock, which is completely enclosed and of symmetrical proportions. This enclosed type of headstock not only lessens the danger of accident, but greatly adds to the massiveness and strength of this part. The driving mechanism is provided with gears having wide faces, and is strongly constructed throughout. There are six mechanical changes of speed, which, together with the changes obtained from the motor, give all the necessary speeds required for a lathe of this size.

A sectional view of the headstock is shown in Fig. 2. The drive from the motor shaft is through a rawhide pinion that is shown directly back of the gear with which it meshes. This driven gear is keyed to a shaft which may properly be called the countershaft. On this countershaft there are three sliding gears which are tied together as one unit. These are brought into engagement with corresponding gears on the lathe spindle by means of the handle shown in the end elevation. By engaging first one and then the other of these gears three variations or mechanical changes of speed are obtained. These three changes are doubled by the use of back gears as in the ordinary lathe. The controller of the motor is mounted on the right side of the carriage, so that while it is convenient for the workman, it is not located so as to interfere with the operation of the lathe. As the illustration shows, this controller is connected through bevel gears to a splined rod extending the length of the bed, which transmits the movement to the starting box. This method of operating the motor from the carriage has proved so satisfactory that all the motor-driven lathes made by this company are so arranged. This lathe is adapted to cut threads ranging from 1/16 inch to 4 inches pitch. The lead-screw is prevented from sagging by a support which travels on the bed with the carriage and automatically stops off at certain points. This insures a longer life to the lead-screw and more accurate work from the machine. The lathe is equipped with power feeds for either longitudinal or cross movements, and, in addition, there is also power feed for angular positions of the compound rest. A dial in front of the headstock is so arranged as to give three changes of feed for screw cutting. There are also two intermediate positions in which the lead-screw remains stationary. This dial, together with a few change-gears, gives all the necessary changes ordinarily required for feeding or screw cutting on a lathe of this size.

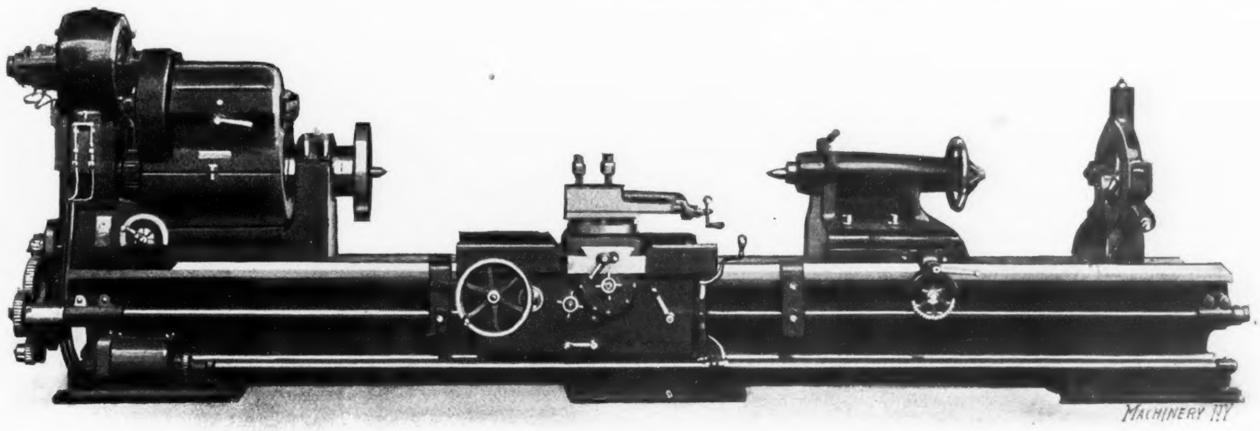


Fig. 1. Heavy Motor-driven Lathe built by the Springfield Machine Tool Co.

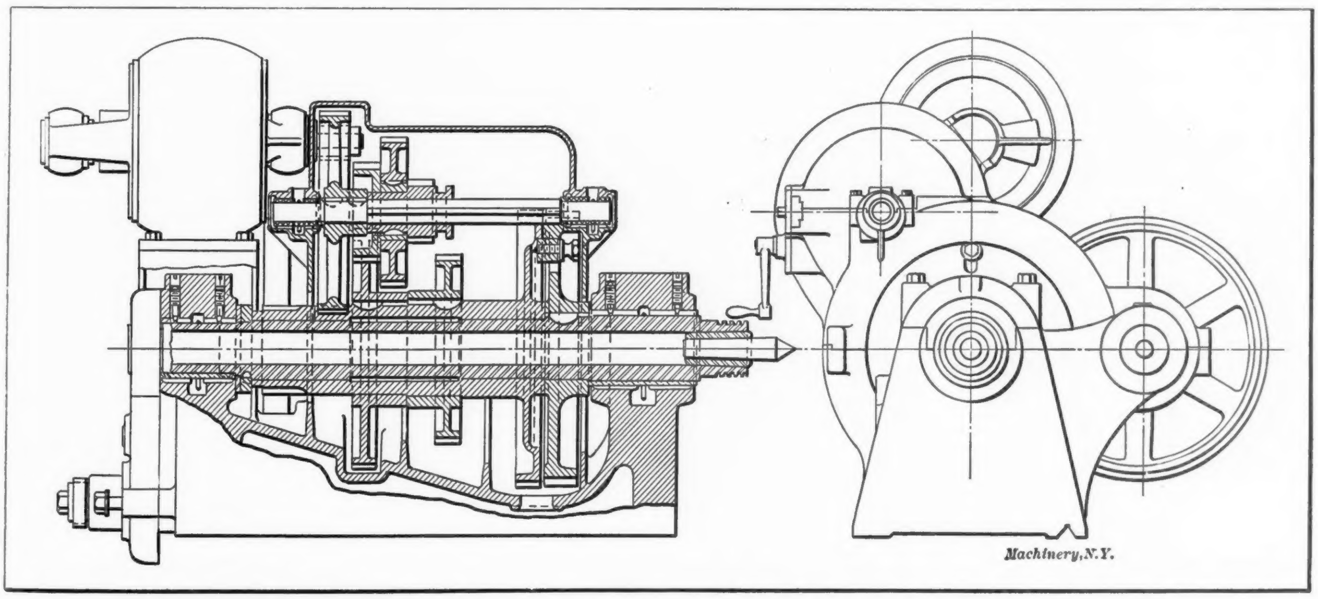
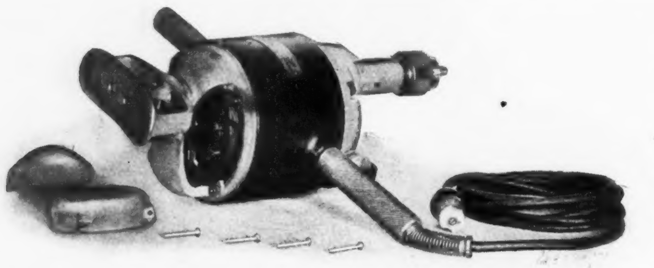


Fig. 2. View of the Headstock of the Springfield Motor-driven Lathe showing Motor and Speed Change Mechanism

ALTERNATING-CURRENT PORTABLE DRILL

The direct-current type of breast drill which has been manufactured for some time by the General Electric Co., Schenectady, N. Y., has worked so satisfactorily that the company has now placed on the market a drill designed for an alternating current. This tool, which is illustrated herewith, while possessing the ruggedness of design required to withstand the hard usage incidental to its service, is constructed as lightly as possible, the weight being only 21 pounds. Lightness, of course, is a desirable feature in a tool of this kind. An indicating control switch for starting and stopping the motor, is located conveniently near the right handle so that it can be operated by the right hand without releasing the hole on the handle. This feature makes the control of the apparatus so simple that the entire attention may be given to the operation of the drill. This machine is equipped with a Jacobs chuck which will take drills up to and including ⅜ inch in diameter. Two knurled side handles and a breastplate, provide ample means for holding the tool securely in any position. Hand holes are provided which furnish a means of easy access to the commutator and brushes for inspection or repairs, when

necessary. The drill is shown in the accompanying illustration with these hand hole covers removed. An idea of the capacity and adaptability of this tool may be had from the following approximate data: A hole three-eighths-inch in diameter and one inch deep may be drilled in cast iron in 27 seconds, or in machine steel in 95 seconds. The machine will

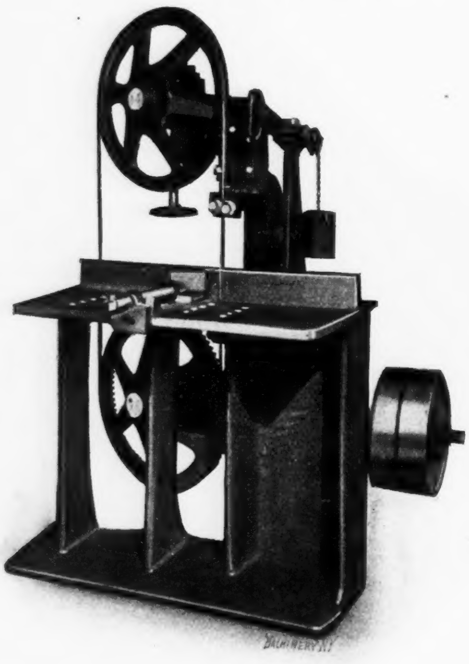


General Electric Co.'s New Drill for Alternating Current

also satisfactorily operate a ¾-inch wood bit. From these figures it is evident that much time can often be saved by the employment of this tool, as it will render unnecessary the moving of heavy castings to the stationary drill for many of the minor drilling operations. This machine is designed for operating on either a 110- or 220-volt, 60-cycle circuit, to which it may be quickly connected by simply screwing an attached plug into a standard lamp socket.

BAND-SAW MACHINE FOR CUTTING METAL

A band-saw that is intended for doing practically the same line of work in the machine shop as that which is ordinarily done by the power-driven hack-saw, is now being built by E. R. Klemm, 103 West Monroe St., Chicago, Ill. This machine, as the engraving shows, resembles somewhat in its design the



Metal-working Band-saw with Gravity Feed

band-saw of the wood-working shop. There are, however, a number of radical changes in its construction which were necessary to adapt it to the work for which it is intended.

The frame of this saw, on which are mounted the band-saw wheels, is free to swing about a bearing at its lower end, and it is by this movement that the saw is fed into the work. The feed is by gravity acting on the weight seen suspended by a chain at the rear. This chain, after passing over the pulleys shown, is attached to the swinging frame which is thus pulled forward. It will be noticed that the band-saw wheels lie in a vertical plane that is inclined considerably to the back or locating strip on the table against which the work is clamped. These wheels are located in this way in order that long stock will not come into contact with the idle side of the saw blade. Means are provided for changing the center-to-center distance of the band-saw wheels, to accommodate saws of different lengths and for varying the tension. The machine is strongly built, and it is provided with a large table equipped with a suitable vise for holding the stock. Practically any shape whether round, square or flat can be held securely and cut to any desired angle. The drive is through a shaft at the rear which has on its end a bevel pinion meshing with teeth cut on the lower band-saw wheel. Two disks, which are located a short distance above the table and on either side of the saw blade, deflect the latter so that it is square with the work.

The maker states that this saw cuts as squarely as any on the market, and also that it severs the stock with considerable speed and with a low power consumption.

BAIRD WIRE FORMING AND FERRULING MACHINE

In Fig. 1 is shown an interesting machine made by the Baird Machine Co., of Oakville, Conn., for the automatic production of pieces such as shown in Fig. 2. These pieces, which are bent in various shapes, have a ferrule around them,

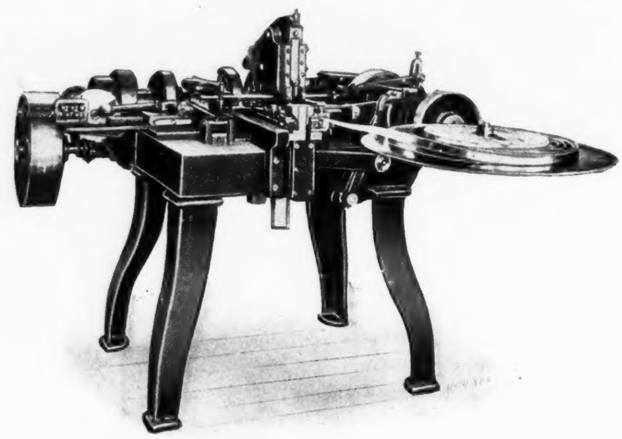


Fig. 1. Automatic Machine for Wire Bending and Ferruling

usually over the closed joint, made from strip metal. Such parts are used extensively for suspender loops, buckles, easel stands for photograph frames, etc.

The machine is a combination of two mechanisms, one of which performs the bending operations, while the other forms the ferrule. The action is entirely automatic. The wire is received from the coil, is straightened, threaded, cut off and formed; and at the same time a strip of sheet metal is received from a reel, is cut off, formed and pressed in place around the work as shown in Fig. 2. The capacity for completely ferruled work is from 60 to 80 per minute, according

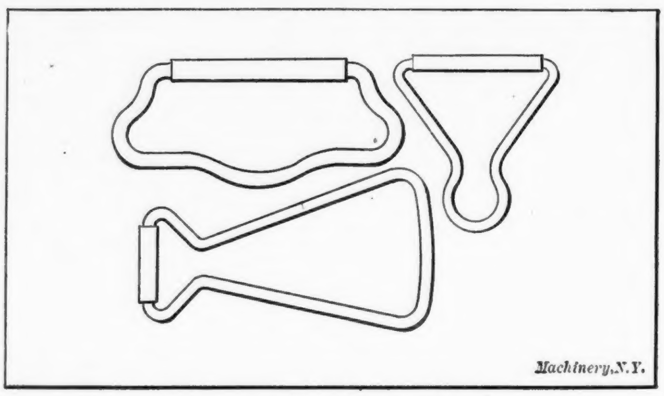


Fig. 2. Character of Work produced

to the size and shape. No further attention is required than that of keeping the machine supplied with strip metal and wire, and removing the finished product.

This machine is built in various sizes and for various styles of work. A high-grade of workmanship and construction is employed throughout, liberal use being made of hardened and ground tool steel for lining, tools, etc. All sliding surfaces are carefully scraped.

SPECIAL LE BLOND MILLING MACHINE FOR JIG BORING

The milling machine is now generally used in the tool room for the purpose of drilling bushing holes in jigs and fixtures, as well as for the machining of the various flat surfaces required in that work. The use of the miller is due to the convenient provision it offers for adjusting the work in two directions at right angles to the spindle, in the provision of a feed in line with the spindle, and in the rugged design and accurate construction, which permit much finer results to be obtained than would be possible on the ordinary drill press, even though supplied with the required adjustments.

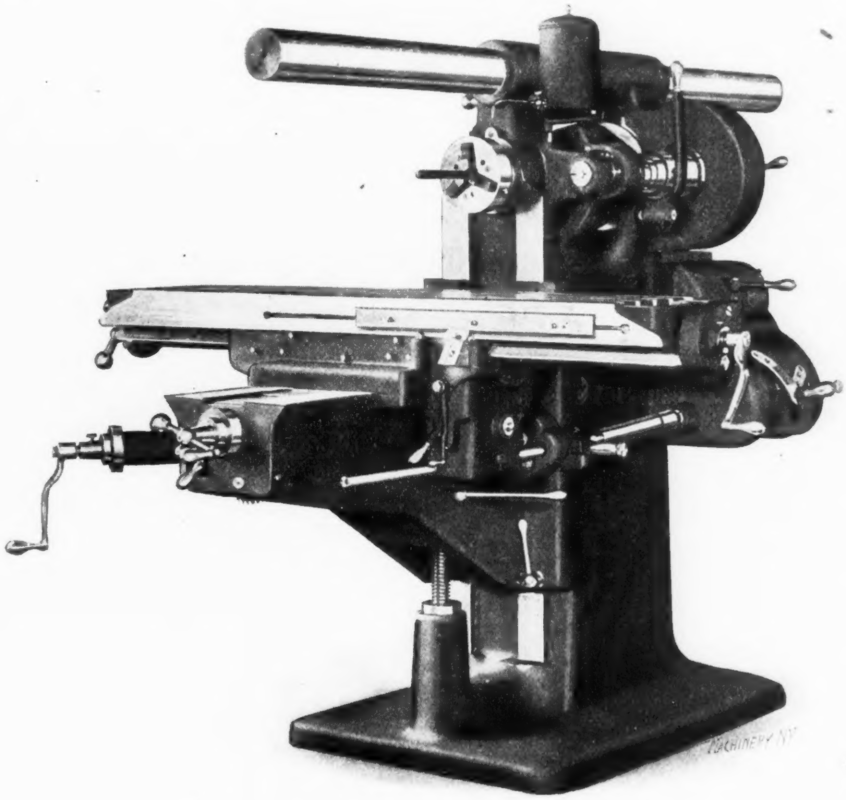


Fig. 1. Miller provided with Vernier Gages and other Conveniences for Jig Boring

The usual method of locating the holes for boring in the milling machine is by the use of ground bushings or "buttons," located by accurate measurements in the positions where it is desired to bore the holes. The buttons thus located are, in turn, lined up with the spindle of the machine by means of indicating devices, and the holes are then bored to the required size.

This button method is exceedingly accurate, but is correspondingly tedious. Another method which has sometimes been adopted consists in fitting accurate scales with vernier attachments to the miller, so as to read the various movements directly without requiring the setting of jig bushings or buttons with special instruments. This greatly increases the rapidity with which such work may be done, but, in general, it has not given as good results as have been obtained by the button method.

The R. K. Le Blond Machine Tool Co., 4609 Eastern Ave., Cincinnati, O., has, however, a special milling machine equipped with vernier scales, in which such care has been taken, both in design and construction as to insure close work. As a result the accuracy in jig and fixture work produced is high enough to meet all except what might be called extreme laboratory requirements, and this accuracy can evidently be obtained with a great saving of time and work for the toolmaker.

The salient features shown by an inspection of Figs. 1 and 2 are the heavy column and wide range of movement provided for the cross and table feeds, the special design of the automatic feed mechanism on the saddle, the increased stiffness of all the structural members and the modified arrangement of the handles, to permit the workman to use them while in a convenient position in relation to the work.

The spindle is unusually heavy. The front taper bearing is hardened and ground and runs in a close-grained cast iron box of special mixture. This insures a permanent bearing that will run indefinitely, showing no wear and requiring little attention. The rear journal is straight and runs in a bronze box fitted to a taper hole in the housing. This box is split and can be drawn into the taper to take up the wear on the rear journal. The end thrust of the spindle is taken by a hardened steel and a babbitt collar. An oil slot is milled in both boxes connecting with reservoirs in the column. These slots are filled with felt, through which the oil filters to the bearings. The arbor is driven by a clutch milled in the end of the spindle nose. An arbor bolt is provided which extends through the hollow spindle, and provides a convenient means of inserting and removing the arbors.

The cone is three-stepped, the largest step being 13 inches in diameter for a 3½-inch belt. The back gears are of the maker's double friction type, which, in addition to all the advantages of double back gears, provides a means for quickly stopping and starting the machine, a feature of equal value to the friction head on a chucking lathe.

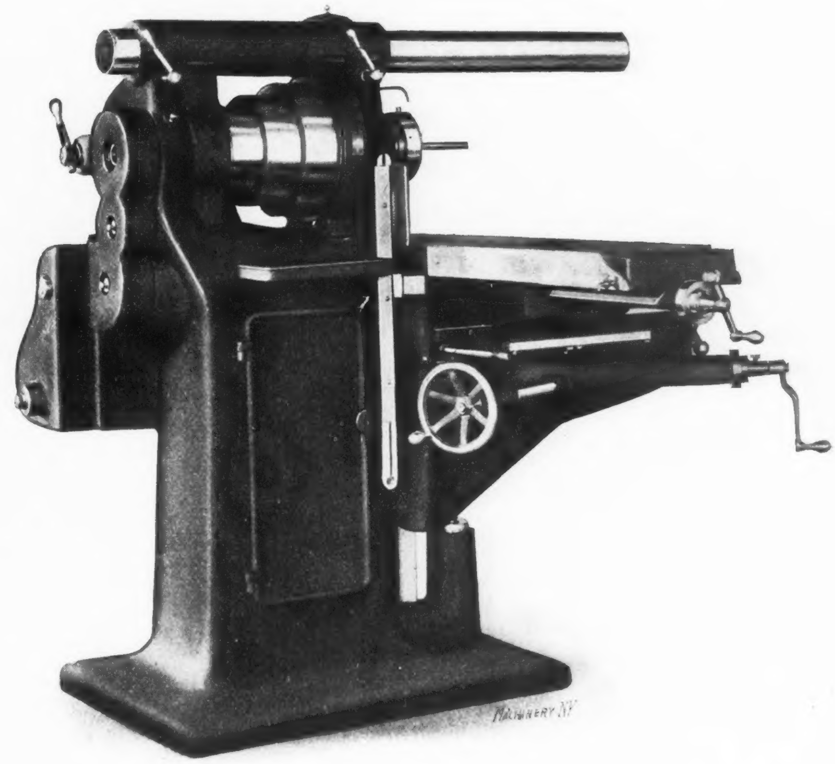


Fig. 2. Side View, showing Arrangement of Adjusting Handwheels and Cranks

The feed box, which is of unit construction, is driven direct from the spindle with spur gears, doing away with all bevels or chains, and thus reducing the friction of the feed mechanism. Sixteen changes of feed are obtained by a system of tumbler and sliding gears, with only two operating levers. These levers are close together, and their movement

is such that a direct reading index plate enables the operator to tell at a glance the correct position for a given feed. The table feed is driven with a direct spur drive on the end of the saddle, instead of the usual construction of coming through the center of the knee and saddle, which further reduces the frictional losses in the feed mechanism. The reverse and trip for the table feed are operated by one lever, the mechanism being carried in a box on the end of the saddle. When the feed is tripped there are no gears or clutches running idle on the screw or in the saddle.

The table is unusually heavy, with arched ribbing to counteract the strains of bolting work on its surface. The bearing is taken on the outside of the dovetail and extends the full width of the table. Large oil pockets extend entirely around the table, and the oil is drained to each end, where it may be removed through cocks provided for that purpose. The table feed-screw is 1¾ inch in diameter, of coarse pitch, and geared 2 to 1 on the quick return. The thrust is taken on ball bearings at the ends of the table, and the screw is therefore always maintained under tension, regardless of the direction of movement.

The knee is made in box section, ribbed and braced transversely and laterally. The column bearing is extended up almost to the top of the table, which adds greatly to its rigidity. The saddle bearing is wider than the column bearing, giving support to the ends of the saddle. The cross feed screw is set in the center of the knee, overcoming all side strains and giving an easy movement. The saddle is of unusual length, and is braced its entire length with arched ribs through which the table screw passes. The taper gib for the table bearing is made with a tongue to avoid any tendency to lift. The lower gib as well as the gib on the column bearing are made with two angles, adjustment being effected with fine thread screws. Locking screws with fixed handles are provided on both gibs, which draws them in like wedges, and these provide metal to metal contacts the entire length of the gibs.

The machine has a longitudinal feed of 34 inches, a vertical feed of 20 inches and a cross feed of 18 inches. The unusual length of the cross movement is one of the chief advantages over an ordinary plain miller for boring jigs, as it permits the use of long boring bars for box jig work and for deep holes. In order to use the machine to the best advantage in boring, the cross feed is arranged in such a manner (see Fig. 2) that its movement can be controlled from the rear of the table—a position most convenient to the operator. This is accomplished by the introduction of the diagonal shaft through the knee which is connected to the cross feed screw at the front by means of bevel gears.

The longitudinal and vertical movements are fitted with vernier scales 24 inches in length, thus enabling the operator to lay off centers with extreme accuracy without the use of auxiliary measuring instruments. An interesting feature in connection with the completion of this machine was the testing of the accuracy of the screws. The vernier scales provided an ideal condition for such a test, which showed the screws so accurate that the error was invisible to the naked eye in a length of twenty inches.

MASSACHUSETTS FAN CO.'S "SQUIRREL CAGE" FAN

The increased use of mechanical ventilation and the extent to which motors and steam turbines are now employed, has resulted in what is called the high-speed or multi-blade fan. This type, because of its high rotary speed, is, of course, for the same capacity, smaller than the older types, for, naturally, the higher speeds make possible a reduction in the wheel diameter; in fact, this diminution in diameter was necessary to keep the rim velocity within practical limits. One of the greatest losses of power in the operation of a fan, is in the creation of an inlet velocity that is entirely destroyed before the air is delivered. In order to decrease this velocity, the area of the inlet is increased to as great an extent as the depth of blade will permit. It is well known that there is a very exact proportion existing between the volume of air delivered and the blade area of the wheel, and in order that the proper blade area may be maintained, a reduction in the depth of the blade must be accompanied by an increase in the number.

By increasing the size of the inlet, using many shallow blades in place of a few deep ones, and increasing the rotary speed, a marked increase in the air delivered and a greater capacity in a given space has resulted. In fans of the older designs, commonly known as the "paddle-wheel" type, the blades were wide apart at the periphery and nearer together at the inner ends. With the blades arranged in this way, the greater density of air at the outer ends caused the formation

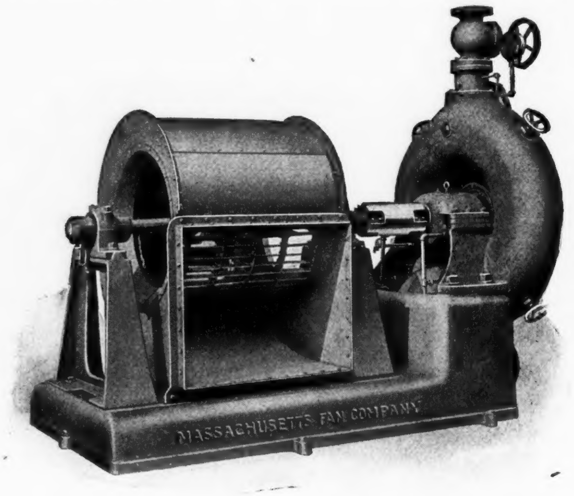


Fig. 1. Turbine-driven "Squirrel Cage" Fan built by the Massachusetts Fan Co.

of eddies and pulsations which reduced the efficiency and caused noisy operation at high speed. In order to reduce the effect of eddies, multi-blade fans were designed so that the air would be subjected to blade action during the shortest period possible. To accomplish this, blades were made very shallow.

The Massachusetts Fan Co., of Watertown, Mass., employs in addition to the blades around the periphery of the blast-wheel or cage, a few long and tapering blades, which extend toward the center of the wheel. These blades may be seen in Fig. 2, which shows a view of the blast-wheel for a double inlet blower. The theory is that these extra blades work with a scooping action which gives the entering column of air a slow whirling motion and a rapid radial motion toward the shallow peripheral blades, thus increasing the efficiency of the fan. Inasmuch as the centrifugal force acting on the entering column of air varies with the speed, the angle of these inner blades should be changed for different peripheral speeds. In order that fans working under different conditions will have a maximum of efficiency, the company referred to has developed three standard designs of the "squirrel-cage" type; these are as follows: Type A for the low peripheral speeds which have been found to be best adapted for building work, and for certain conditions for high pressures when the fans may be driven by a direct-connected steam engine; type B for higher peripheral speeds such as those of high-speed motors,

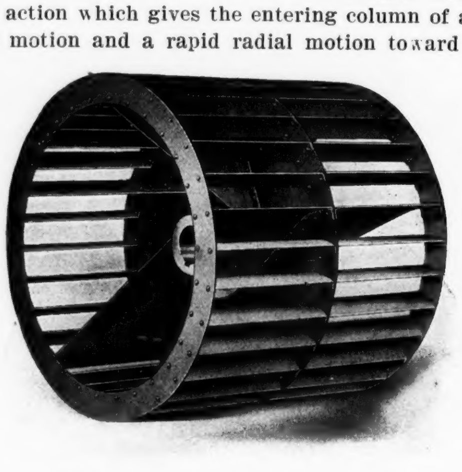


Fig. 2. Blast-wheel or Fan Runner of the Double Inlet Type

especially of the alternating current type; type C for very high speeds, as when driven by steam turbines.

One of these squirrel-cage fans of the double-inlet type is shown in Fig. 1 directly attached to a steam turbine.

SPECIAL WALTHAM BENCH LATHES

The Waltham Machine Works, Newton & Cutter Sts., Waltham, Mass., has for many years manufactured a line of bench lathes which are used for general manufacturing and special work, where parts to be made are small or require great precision in workmanship. These lathes are regularly provided with tailcenter, slide-rest, etc., and used in the same way as the largest size engine lathes in the machine shop.

A number of special appliances are provided for them, however, by means of which they may be converted into special machines. Some of these arrangements, of recent design, are herewith illustrated and described.

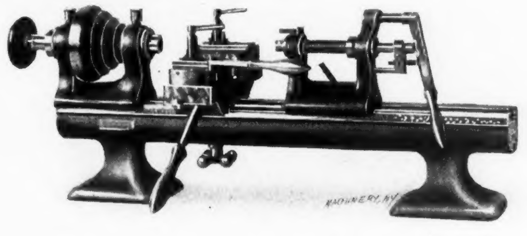


Fig. 1. Precision Drilling, Turning and Cutting-off Lathe

In Fig. 1 is shown a drilling, turning and cutting-off lathe, consisting of a plain head with a spring chuck, a double slide-rest and lever tailstock, mounted on a two pedestal bed. The movements of the various slides are controlled by lever, so that the action is very rapid. Stops are provided in all directions. The front toolpost on the cross-slide is mounted on a compound block which may be set to any desired angle, so that either cylindrical or taper surfaces may be turned and bored by the manipulation of the upper handle.

Fig. 2 shows a shortened one-pedestal lathe bed on which is mounted a headstock and a grinding wheel slide. This machine is intended for grinding small short work, one end of which is held in a spring chuck, while the other is supported by a center in a bracket attached to the back side of the headstock. A grinding wheel is mounted on a traverse spindle in a swivel support which may be set to any angle desired.

Fig. 2. Special Grinding Lathe with Self-contained Measuring Indicator

An indicator is shown, which is provided with a sapphire point bearing against the work. This records the diameter, so that it is not necessary to stop the spindle and take measurements for every piece, this being done only occasionally.

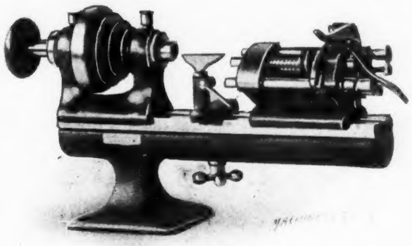


Fig. 3. Precision Lathe with Three-spindle Tumble Tailstock

The machine shown in Fig. 3 is a combination of a plain chuck headstock, a hand-rest and a three spindle "tumble" tailstock, mounted on a single pedestal bed. The center spindle of the tailstock can be driven by a belt, thus making it an excellent tool for spotting, drilling and reaming small holes.

The machine illustrated in Fig. 4 is provided with a headstock of special construction. The cross-slide is similar to that shown in Fig. 1. The lathe tailstock is of the "half bearing" variety, which may be provided with a multiplicity of spindles, each containing one tool of a number which it may be desired to use. Each spindle has its own stop, so that each may be set independently. To change from one to the other it is only necessary to pick out one tool and lay in the next in order. The headstock is of the slide spindle type, with a lever-operated chuck and wire feed. A two-step cone pulley

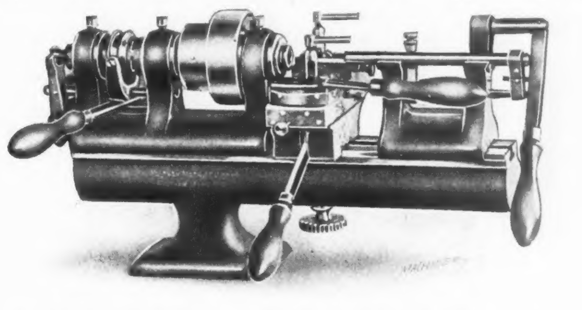


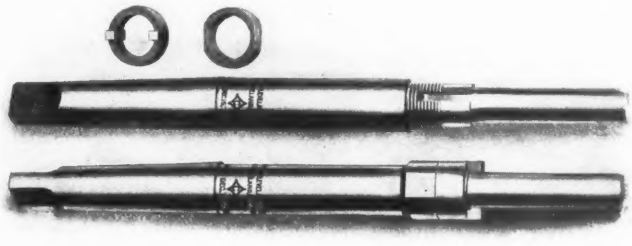
Fig. 4. Lathe with Double Lever Cross-slide and Half-bearing Tailstock adapted to Screw Machine Work

is provided. This equipment is used in much the same way and for the same kind of parts that in larger work would be placed on a hand or automatic screw machine.

The various lathes here illustrated have, for the most part, a swing of $3\frac{1}{4}$ inches and a chuck capacity of 5/16 inch. Three other sizes are made, however, swinging $6\frac{3}{4}$, 7 and 8 inches, with $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{5}{8}$ inch chuck capacity, respectively. These lathes, with special equipment, are usually made only to order, though the makers occasionally have some of the parts in stock. As all the equipment of one size is interchangeable, any style of headstock can be used with any style of tailstock and slide rest, giving several other combinations in addition to those shown.

CLEVELAND TWIST DRILL COMPANY'S SHELL REAMER ARBOR

The Cleveland Twist Drill Co., Cleveland, O., is about to place on the market a new patented arbor for shell tools. The principal difference between this arbor, which we illustrate here-



New Cleveland Shell Reamer Arbor with Adjustable Locking Collar and Tool-releasing Nut

with, and the regular type is that it is equipped with an adjustable collar, provided with integral locking keys which slide in longitudinal keyways. This collar engages the shell reamers in the usual way. The arbor is threaded for a short distance to receive an adjusting nut which bears against the collar containing the locking keys. Perhaps the chief advantage of the new arbor is the quickness and ease with which it releases a shell tool, no matter how tightly it may have become jammed on the arbor. This is accomplished by a turn or two of the adjusting nut, and without the necessity of removing the arbor or resorting to the vise and hammer methods which often cause considerable damage. Another decided advantage is that the collar can always be set so as to allow the shell tool to fit snugly on the arbor, and yet fully engage the collar keys.

CINCINNATI-BICKFORD $2\frac{1}{2}$-, 3- AND $3\frac{1}{2}$-FOOT RADIAL DRILLS

The radial drilling machines made by the Cincinnati-Bickford Tool Co., Cincinnati, O., (formerly made by the Bickford Drill & Tool Co.), are well known in their general characteristics. The smallest sizes of this line ($2\frac{1}{2}$-, 3-, and $3\frac{1}{2}$-foot) have recently been redesigned by the makers. The main characteristics have been retained and there is, in fact, com-

paratively little change in their appearance. Improvements have been made, however, throughout the whole structure and mechanism of the machines, radically affecting the strength, durability, convenience, accuracy and productive capacity.

The design has a column extending to the top of the sleeve, ribbed internally so as to furnish a high degree of stiffness. It is mounted on a base which has been considerably strengthened at the point where the flange is bolted down. The ring which supports the elevating screw and takes the weight of the arm itself, is now supported on ball bearings, greatly reducing the force required to swing the arm. The pipe section of the arm has been retained, giving a high degree of strength and stiffness. In fact, in the matter of the general structure of the machine, all that was good in the old design has been kept, with the addition of improvements that increase its efficiency.

The power of the drive has been augmented by putting on a larger driving pulley, giving, consequently, a greater belt capacity. The well-known form of gear box provided, allows changes to be made while the machine is running at a high speed, by the simple tossing of the lever from one notch to the other. This can be done without taking special precaution to prevent breakages. The settings for the different diameters of drills are given below the notches in which the change gear lever rests. Gears subjected to hard service are of hardened steel. The bevel gears transmitting the power to the column have been increased in size, so as to make them proportionate to the greater power transmitted.

The back-gears are located in the head. They are of simple construction, consisting of three gears and a clutch, and may be engaged or disengaged while running. The clutch is made of high-grade carbon steel and has hardened teeth. The gear-box and back-gears give twelve changes of speed, ranging from 38 to 356 revolutions per minute, making them correct for a cutting speed of 35 feet per minute for drills from ⅜ inch to 3½ inches in diameter. This increased speed range is a new feature in this design.

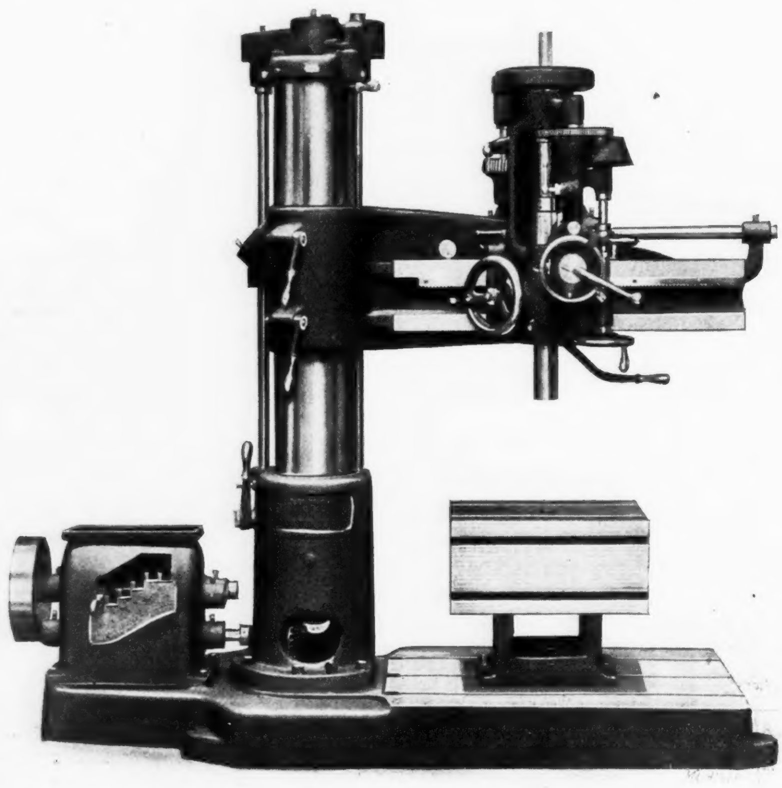


Fig. 1. Improved Design of Cincinnati-Bickford Radial Drill

The reversing clutch, the lever for which may be seen extending below the head in Fig. 1, is now expanded by a plunger and toggle-joint arrangement, whereby its capacity is increased many times over that of the wedge type of clutch formerly used. Adjusting screws permit the friction rings to be set to any tension desired. The reversing lever is employed for starting and stopping the machine as well, being within convenient reach from the operator's position.

The feed change device operates by means of a ball handle controlling a driving key mechanism. This gives four changes ranging from 0.008 to 0.020 inch advance per revolution of the spindle. Any one of these feeds is instantly available. The feed clutch is made of hardened steel. The thrust of the feed worm is taken on a ball bearing instead of on a fiber washer, reducing the power consumed by this member of the machine. The spindle sleeve also exerts its pressure on the spindle through a ball thrust bearing, reducing the power to run the machine nearly 22 per cent. This, with the increased diameter of the driving pulley, makes the machine capable of doing much heavier work than formerly.

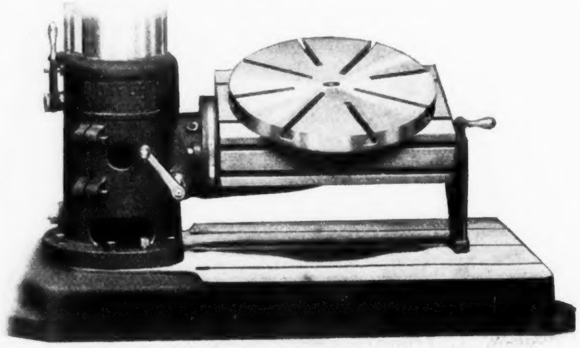


Fig. 2. Universal Swinging, Tilting and Rotating Work Table

The quick return handle on the feed pinion shaft is now provided with a toggle-joint type of adjustable clutch. This requires but a slight force to engage it, thereby avoiding the possibility of throwing the handle out of position by a sudden violent effort. Instead of graduating the spindle sleeve as formerly, depths are now read from a dial permanently located on the quick return head on the feed pinion shaft. The automatic stop is also made a part of the depth gage, and it may be set in position instantly without requiring trial cuts or measurements.

The guide on the top of the arm for the adjustment of the head is made flat instead of angular as usual, thereby allowing the head to move more easily, and minimizing the tendency for it to rock on the arm while the machine is in operation. The head clamping device has the important feature of tightening the gib in the head instead of lifting it away from it. This gib is now made taper instead of flat and is fitted with an improved adjusting device which eliminates the undesirable feature of having the weight of the head rest on the point of two screws. It also prevents the possibility of any end play.

Three forms of table are provided. Fig. 1 shows the box table clamped on the base of the machine, and provided with working surfaces on both sides as well as on the top. Fig. 2 shows a swiveling table provided with a wormwheel adjustment for setting it to any angle about a horizontal axis, the angle being indicated by a graduated ring of large diameter; a dowel is provided for locating it in the horizontal position. This design is also furnished, if desired, as a plain swinging table, without the swiveling attachment. The round work-table shown is a supplementary device which may be placed on the box, swinging or swiveling tables.

Special attention should be called, in Fig. 1, to the very complete set of gear guards provided. This is in line with the modern tendency of safe-guarding the workman. It has other advantages as well, however. It protects the gears from accidents, such as are particularly likely to occur in shops having traveling cranes. It prevents the throwing of oil over

the clothes of the operator. Besides all this, it adds so much to the appearance of the machine that it would seem to be a commercially profitable policy to provide complete gear guards on that score alone.

These machines are made in 2½, 3- and 3½-foot sizes, which dimensions give the radius of the circle to the center of which it is possible to drill on the base of the machine. The vertical adjustment of the arm is about 53 inches for each of the three sizes. The maximum height of the end of the spindle above the base is about 4 feet 3 inches. The vertical range of the spindle is 11 inches. It is bored for a No. 4, Morse taper. The weights of the 2½-, 3-, and 3½-foot machines with swinging table, are, respectively, 4,100, 4,250 and 4,400 pounds.

SIBLEY HIGH-SPEED GEARED DRILL

The Sibley Machine Tool Co., South Bend, Ind., makes a high-speed drill, which was illustrated in the department of New Machinery and Tools in the November, 1909, number of MACHINERY. This machine has recently been equipped with an all-geared power feed, which is illustrated in the accompanying engravings together with details of the speed change mechanism.

The gear-box for the feeds is mounted at the side of the lower spindle head, being connected in the casing at the top of the column with the horizontal spindle driving shaft. Four sets of gear ratios are provided, the change from one to the other being made by the sliding key mechanism operated by the knob plainly shown in the hub of the handwheel, which, it will be seen, places it within convenient reach of the operator.

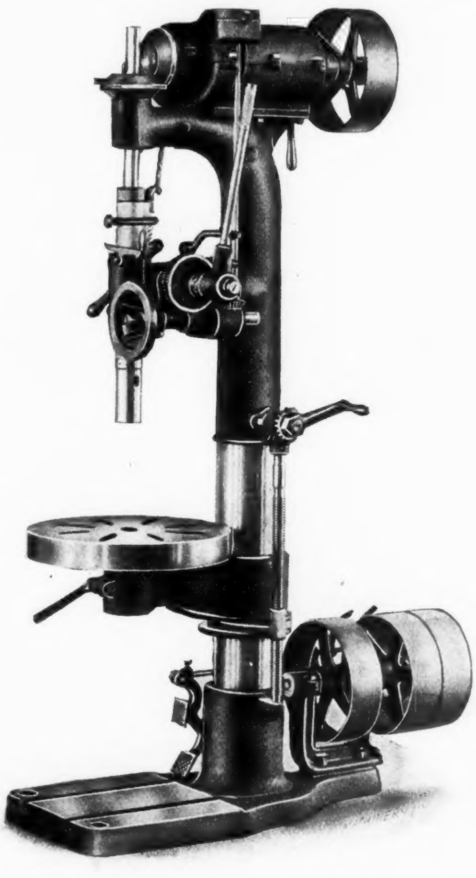


Fig. 1. Sibley Drill Press with Geared Quick-change Speeds and Feed

The usual drop worm mechanism is provided in connection with an automatic stop, actuated by an adjustable clamp dog on the spindle sleeve. A lever is provided for quick handling of the spindle for light drilling operations, while the handle at the left-hand end of the pinion shaft serves for the quick return movement.

The control of the spindle speeds will be understood by reference to Figs. 2 and 3. The constant speed driving pulley may be connected by either of two sets of gearing with the horizontal shaft at the left of the casing. The change from one set of gearing to the other is made by the lever shown in Fig. 2, just in front of the driving pulley at the top of the machine. This second shaft also carries a set of four gears meshing with a corresponding set of four gears on the spindle driving shaft, to which the driving bevel gear is connected. By the manipulation of the lever at the front, any of the four ratios provided may be obtained. The combination gives eight changes in all. The elimination of the cone pulleys permits the use of a wide belt running constantly at a high speed, giving greater power, besides having the obvious advantage of simpler and more rapid manipulation.

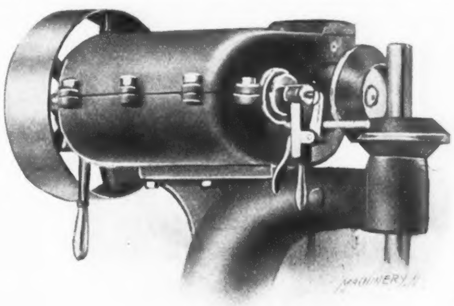


Fig. 2. Speed Change Box and Handles for Operating

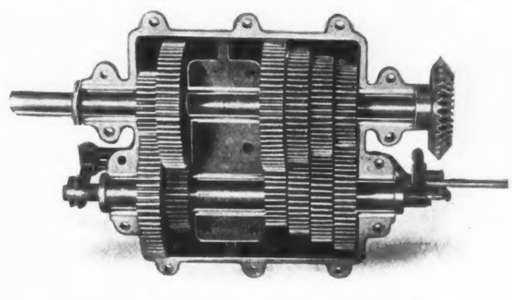


Fig. 3. Arrangement of Gearing in Speed Box

The bearings in the speed box are of bronze, the gears run in oil, and the whole construction is rugged and strong. All the changes of spindle speeds and feeds can be controlled without leaving the operator's position at the front of the table. The speed change is of the selective type—that is, the required speed may be obtained without running through the intermediate speeds and without stopping the machine. All the bearings are long, and the spindle and shafts are ground. The stiffness of the column is apparent in the illustration.

This style of machine is built at present only in the 22½-inch swing size. The total height of the machine is 6 feet, 5½ inches. The maximum distance from the spindle to the base is 39¾ inches, and from the spindle to the table, 19½ inches. The table is 19 inches in diameter. A No. 4 Morse taper hole is provided in the spindle. The eight speeds range from 99 to 600 revolutions per minute, while the feeds range from 0.0052 to 0.0169 inch per revolution. The spindle has a feed of 7 inches. The weight of this machine is about 850 pounds.

ROCKFORD ADJUSTABLE COLUMN GANG DRILLING MACHINE

In Figs. 1 and 2 is illustrated a novel design of gang drill, made by the Rockford Drilling Machine Co., of Rockford, Ill. As will be seen, the new feature is the provision made for adjusting the columns to different spaces along the planed top surface of the base. This allows the machine to be used, of course, for ordinary gang drilling operations, in which its merit over the use of four separate machines is principally that of compactness; but it makes it available as well for a large range of work which comes under the head of multiple spindle drilling—that is to say, it is adapted to the drilling of four holes in a line simultaneously on a given piece of work, or two holes in two pieces of work; and the spindles may be spaced to drill these holes at the different dimensions required.

The base has a planed top surface, provided with two T-slots in which each column is clamped by four stout bolts. A tongue in the rear T-slot serves to guide the columns and keep them in line. Each pair of columns is connected with

a screw by means of which they are adjusted along the top of the bed to the desired position. In this adjustment one column is clamped, while the other one is free to move under the influence of the screw. When this column has been moved to the desired position, it is clamped, in turn, and the other one is loosened and adjusted by the operation of the same screw. The minimum adjustment is 13 inches, center to center, for each of the pairs, and the maximum 30½ inches,

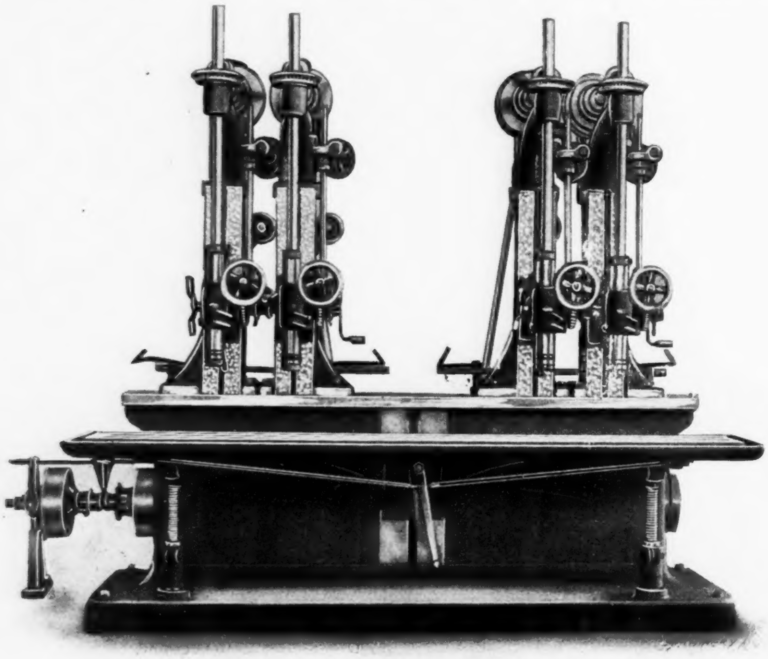


Fig. 1. A Four-spindle Gang Drill with Adjustable Columns

center to center, between the adjacent spindles.

This adjustable column arrangement introduces a problem in the provision of a suitable belt drive, and bracing for supporting the belt pull. These problems have been solved in a way best shown in the rear view of the machine, Fig. 2. In place of the usual solid brace, running from the lower drive cone frame to the arm at the top of the machine, a strut has been provided which is pivoted at both top and bottom. At the lower end this is fitted into a socket where it is held by screws. Before the adjustment on the columns of the bed is changed, these screws are loosened, permitting the strut to slide freely in and out. When the adjustment has been made and the column is clamped in place, the screws are again tightened, to provide the compression strains due to the belt tension with a resisting member at this point. The tension under the varying adjustments is maintained by means of the idler pulleys shown, which work on the slack side of the belt, and may be adjusted to the belt's position.

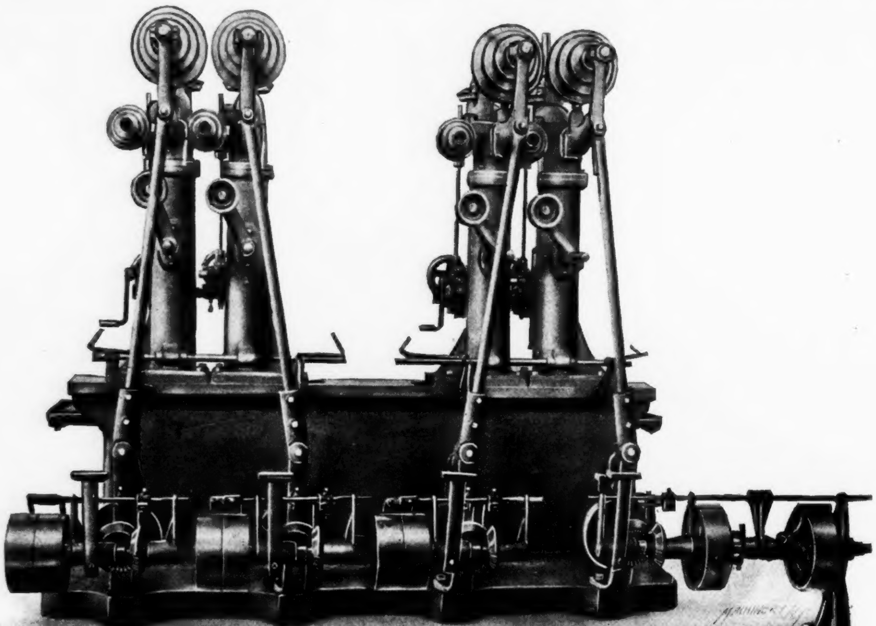


Fig. 2. Rear View of Gang Drill, showing Adjustable Back Braces and Belt Idlers

Each head is provided with a separate set of cone pulleys and a separate countershaft with its own tight and loose pulley and shifting lever, which is brought around to the front of the machine between the columns, where it can be readily handled by the operator. Power feed with automatic stop is provided for each of the spindles, thus making them independent.

The tool illustrated has the same dimensions and capacities for the individual spindles as the makers' regular 28-inch gang drill. Eight speeds are provided by the use of the internal back-gears, and there are four changes of power-driven feed. The table is mounted on two raising screws, geared together for changing the height adjustment. It is tongued and gibbed to the column, and may be rigidly clamped in place.

ALMOND GEARED DRILL CHUCK

T. R. Almond Mfg. Co., of Ashburnham, Mass., has made further improvements in the chuck with which its name has been connected for many years. The new design has the same internal construction as the original standard chuck, the improvements consisting in the application of a tightening device operated by a bevel pinion cut on the end of the tightening wrench. This construction is shown in the engraving.

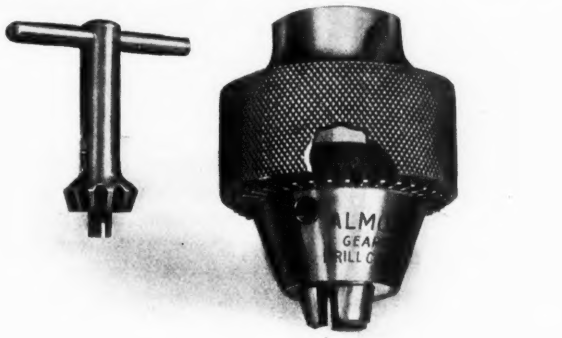
The main point of advantage in the new design relates to the gear teeth. Instead of being cut on the knurled sleeve as usual, they have been formed on the edge of the split nut or ring which operates the jaws. This nut is made of hardened and tempered tool steel, giving a great increase in durability and strength as compared with former designs in which the teeth are cut on ordinary mild, case-hardened metal in the sleeve. There is also an advantage in applying the tightening power directly to the nut, since it has been noticed that the frequent pressing of the sleeve on or off of the nut for cleaning purposes in the old design, tended to loosen the fit, so that the sleeve would slip when a firm tightening pressure was applied. The knurled sleeve is still, of course, available for quick adjustment by hand, the same as with the original construction.

Another improvement consists in bushing with hardened steel the holes in the body of the chuck, which receive the pilot of the pinion wrench, when the jaws are being tightened. These holes are subject in ordinary workshop practice to very severe usage, and by bushing them in this manner the fit of the gear teeth and the consequent satisfactory action of the chuck is prolonged indefinitely. This new design employs the same size pinion for both sizes of chuck, so that they are interchangeable. The wrench may, in fact, be chained to the drill press the same as the drift key, and be used for whichever size of chuck the workman happens to employ.

Improvements in general construction have resulted from the cutting of the teeth on the nut instead of on the edge of the sleeve. One result is the increase in the diameter of the nut and the consequent enlarging of the thrust area. The surfaces are thus better adapted to withstanding the pressure and

wear imposed on them when the jaws are forced out to receive the tool. The lubricant is also retained in these surfaces for a much longer period. This means that a greater tightening force may be safely employed, giving a higher gripping power.

The Almond chuck is made in three sizes. No. 1 takes up



Geared Drill Chuck of Improved Construction

to 3/16 inch, No. 2 up to 5/16 inch, and No. 3 up to ½ inch diameter. The two larger sizes only are furnished in the geared style, as No. 1 size will hold securely by hand tightening anything up to its capacity. The geared and standard designs in the larger chucks are furnished at the same price. The pinion wrenches are made of high grade tool steel, tempered, and have a high durability, so that replacements are

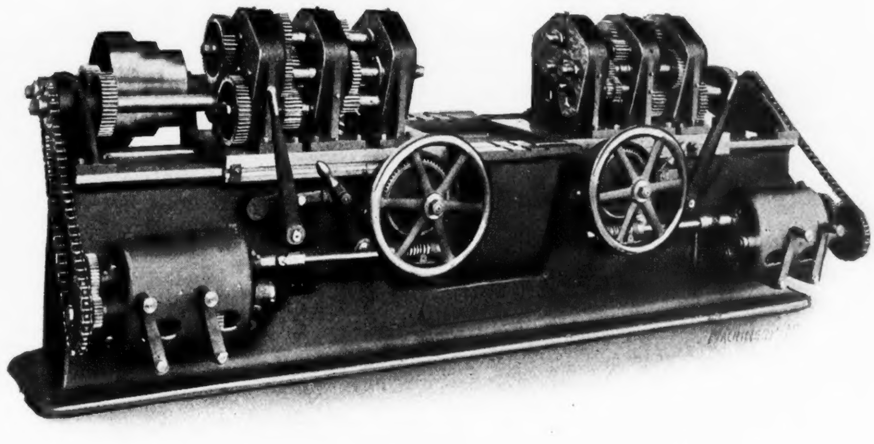


Fig. 1. A Transmission Case Boring Machine which provides for a Variety of Lay-outs

unnecessary. As in previous designs, long life and continued accuracy in the chuck itself have been secured by the high quality of materials employed, and a high grade of workmanship.

BEAMAN & SMITH TEN-SPINDLE TRANSMISSION CASE BORING MACHINE

The accompanying illustrations show a ten-spindle boring machine made by the Beaman & Smith Co., of Providence, R. I. It is intended for the special work of boring the shaft and intermediate stud holes in automobile transmission gear cases. These holes are bored from both ends of the case simultaneously, and provision is made in the arrangement of the spindles for different lay-outs for the positions of the shafts in the work. In the example shown the spindles are arranged for cases of four different designs, as indicated in Fig. 2; three of these are of the vertical type (Nos. 1, 2 and 4), while the other (No. 3) is of the horizontal type. The distances between the main shafts in Cases 1 and 3 are the same, and in Cases 2 and 4, but the lay-outs for the intermediate stud may be different for each, by having two of the spindles for these in one head and two in the other.

The general arrangement of the tool will be easily understood from Fig. 1. The machine consists of a long base provided with ways on its top surface on which slide the two spindle heads. These latter are each driven by separate cone pulleys and each is provided with its own feed mechanism, so that the two may be operated entirely independently of each other, both as to feeds and speeds. The work fixture is clamped to the top surface of the slide brackets which may be seen extending out front and back of the machine between the heads. Suitable T-slots and grooves are provided for

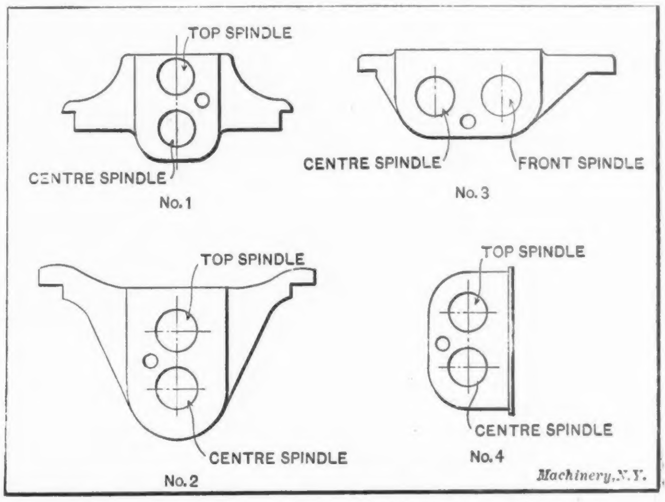


Fig. 2. Four Designs of Case for which Machine is adapted

locating it and bolting it down. The spindle head slide will be seen to extend forward of the heads, passing underneath the fixture when fed up to the work. The various boring tools are thus firmly supported, having a thrust directly downward onto the bed of the machine without any real overhang.

Three threaded spindles and two smaller slotted ones are provided on each head. The former bore the holes for the main and secondary bushings, while the latter drill the holes for the intermediate studs. Not more than three spindles in a head are in use at one time. The ordinary arrangement would be to have three employed in one head and two in the other, since the intermediate stud hole is found at one end of the work only. For boring the vertical type of gear-box, the top and center spindles, as shown in Fig. 1, would be used, with the upper of the two slotted spindles. For the horizontal type, the center and front spindles would be used, with the lower of the slotted spindles for the intermediate stud. The arrangement of the intermediate stud holes may be somewhat different in the left-hand head, making provision for different lay-outs, as has been explained.

The method of driving the various spindles and of chang-

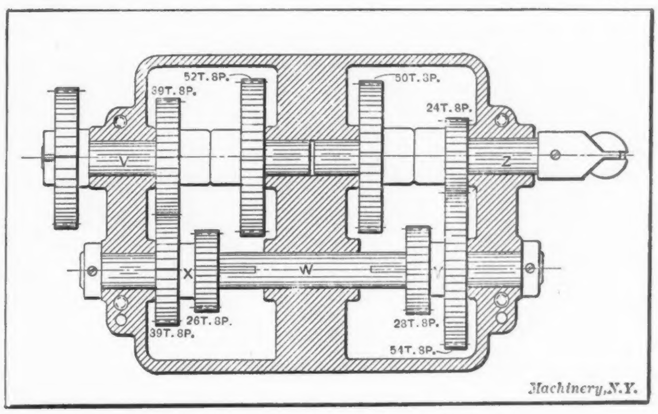


Fig. 3. Arrangement of Gearing in Feed Box

ing the connections for either the horizontal or vertical types is most plainly shown in Fig. 4. Gears E and F are driven from the pinion on the driving shaft geared to the cone pulley (see Fig. 1), and revolve continuously. Gear E drives shaft A, which has mounted on it a slip gear D, which may be changed to take the position D' if desired. In the position D,

this slip gear engages gear G on the center spindle H. (It should be understood that this diagram is a development and not a plan.) In the position D' it drives gear J, which is connected to the top spindle K. This spindle, in turn, carries a gear L which, through intermediate gear M, drives pinion

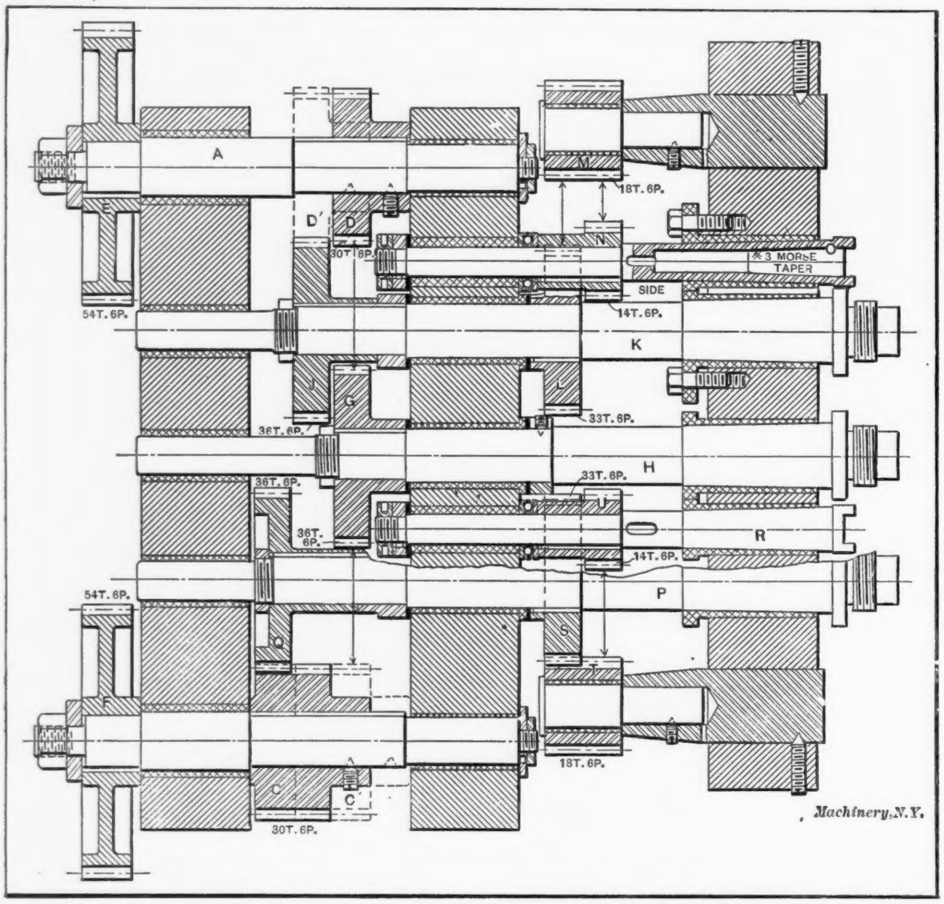


Fig. 4. Arrangement of Head Gearing, by means of which Spindle Movements are controlled

N on slotted spindle O. Thus in position D, center spindle H is driven, while in position D', top spindle K and slotted spindle O are driven.

In a similar manner, gear C has two positions. In the position shown, it drives front spindle P through gear Q and also slotted spindle R, which is connected with P through gears S, T and U. In position C', center spindle H only is driven through gear G.

It will be seen that in the position shown, with the slip gears at C and D, spindle H, slotted spindle R and front spindle P are being driven. This is the combination used for the horizontal transmission case. For the vertical case, the slip gears are changed to position C' and D', driving top spindle K, slotted spindle O and center spindle H. The three-step cone pulleys provide three changes of speed for each head.

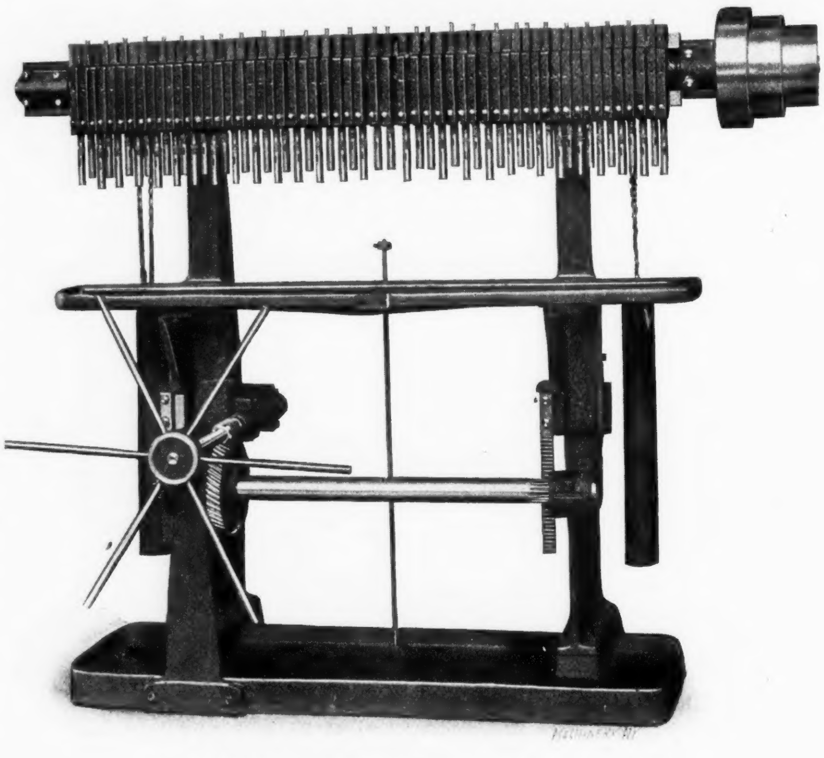
The gear-box gives four changes of feed; the construction is shown in Fig. 3. Motion is received by shaft V, which is provided inside the casing with two gears, one of 39 and the other of 52 teeth, as shown. On the intermediate shaft W is mounted the double gear X, either end of which may be engaged with the corresponding gear on shaft V by manipulating one of the handles shown at the front of the casing. At the other end shaft W carries a similar double gear Y, either side of which may be thrown into engagement with the mating gears on shaft Z by the operation of the second lever on the front of the casing. Four speeds may thus be given to shaft Z for each speed of shaft V, by the manipulation of the two levers of each gear-box. The feed is through a rack and pinion motion, driven by worm-gearing. An automatic stop is provided to arrest the feed, when the proper depth of boring has been reached. The length of feed is about two feet, and quick power movement is provided in each direction. The control handles are all in convenient reach of the operator. All feeds and speeds are positive. The machine is shown in Fig. 1 with all the gearing exposed. This is done simply to show the arrangement of the drive in actual use. Guards are provided which completely protect the gears from accident, either to themselves or to the operator.

This machine will, of course, be furnished with heads to suit any lay-out of transmission case. It weighs about 9,500 pounds.

MOLINE MULTIPLE SPINDLE DRILL

The multiple spindle drill made by the Moline Tool Co., of Moline, Ill., is unique in a number of particulars, especially in the closeness of spindle spacing permitted by the construction, the wide range of horizontal adjustment provided, and the ingenious arrangement of the drive. These characteristics are well illustrated in the special drill of recent design shown herewith.

The cross-rail at the top of the machine is provided with ways along which the narrow spindle heads are adjusted. Journal bearings are placed at each end for supporting a spiral gear which extends the full length of the ways. This spiral gear has further support besides that given by the journals, having a continuous bearing on its outside diameter in a seat formed



A Fifty-eight Spindle Drill, permitting Unusually Close Spacing

in the cross-rail. The heads are of steel to give them the required strength and stiffness in the very narrow width allowed them. The spindles are of tool steel, ground to size,

and run in bronze bushings. They are provided with ball thrust bearings. The lower bushing is threaded to give a vertical adjustment accommodating different lengths of drills. These heads are but ⅞ inch thick and may be brought close up into contact with each other, so that the minimum spacing possible is ⅞ inch.

The table is mounted on brackets gibbed to ways on the face of the housings at each end of the machine. The feed is by a rack and pinion movement. The pinion teeth are cut directly in the heavy feed shaft shown. In the particular case here illustrated, hand feed only is provided, being applied by a pilot wheel connected to the shaft by worm-gearing. Power feed will be furnished when desired. The table is counterweighted, and a stop is provided for its vertical movement, thus limiting the depth of holes drilled.

In the machine here illustrated, fifty-eight spindles are provided, but, of course, only as many of these will be furnished as are required by the purchaser. The adjustment range gives a minimum of ⅞ inch and a maximum of 5 feet. The machine is intended for light drilling particularly, but where comparatively few spindles are used drills as large as 5/16 inch may be employed.

IMPROVEMENTS IN KINKEAD SHAFT LEVELING APPARATUS

In the June, 1909, issue of MACHINERY, we illustrated a line of shaft leveling apparatus made by the Kinkead Mfg. Co., 7 Water St., Boston, Mass. This apparatus consists essentially of a special architect's level, a portable target hung from the shafting to be lined up, and a fixed target attached to a wall or other convenient permanent support. A line is established between the level at one end and the fixed target at the other. The portable target is moved along the shafting, to successive locations near each of the hangers, in turn. Error in alignment is noted through the telescope of the level by direct reading on notched graduations provided in the target. The method of doing this is given in detail in the article referred to, and will not be enlarged on here.

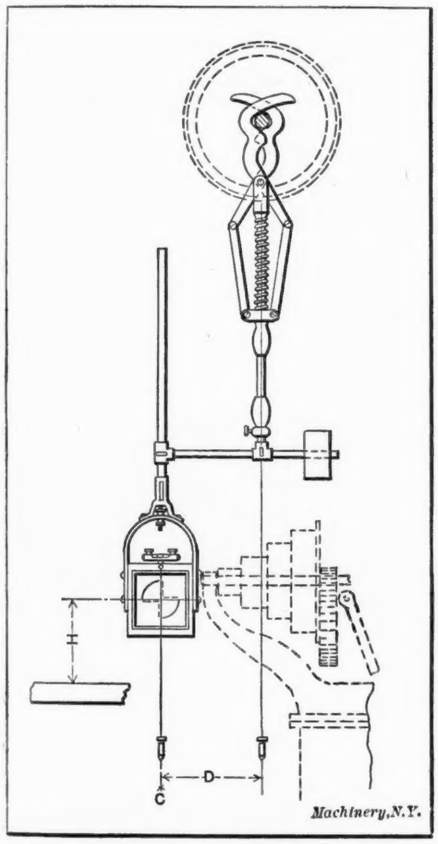


Fig. 1. Running a Line around Obstructions

The makers of this device have recently provided attachments and improvements which enlarge its range and increase its convenience, particularly in the aligning of shafting located in other positions than the usual one of suspension from the ceiling. The various attachments and methods of using them are illustrated in Figs. 1 to 4, inclusive.

Fig. 1 shows a difficulty occasionally met with. In this case, owing to the location of machines or other obstructions, it is impossible to run a straight line directly beneath the shafting, so offsetting the line has to be resorted to. In this case a special offset fixture is provided, as shown, with an adjustable counterweight which is used to bring the device into plumb in the vertical position. The vertical plumb-bob is used as in the regular apparatus to determine when this vertical position has been obtained.

Occasional cases are found in which shafting is laid in pits or beneath the floor. Provision for lining up shafting thus located is shown in Fig. 2. Here the portable target is reversed, being supported in this upright position by an adjustable leg at the side, as shown. The plumb-bob also has to be reversed, of course, being hung from the target itself.

For shafting located in pillow blocks on piers, the arrangement shown in Fig. 3 is employed. This is preferable to the vertical arrangement shown in Fig. 2 since this shafting is usually very heavy and the pulleys on it large, and the horizontal position enables the operator to work from the floor.

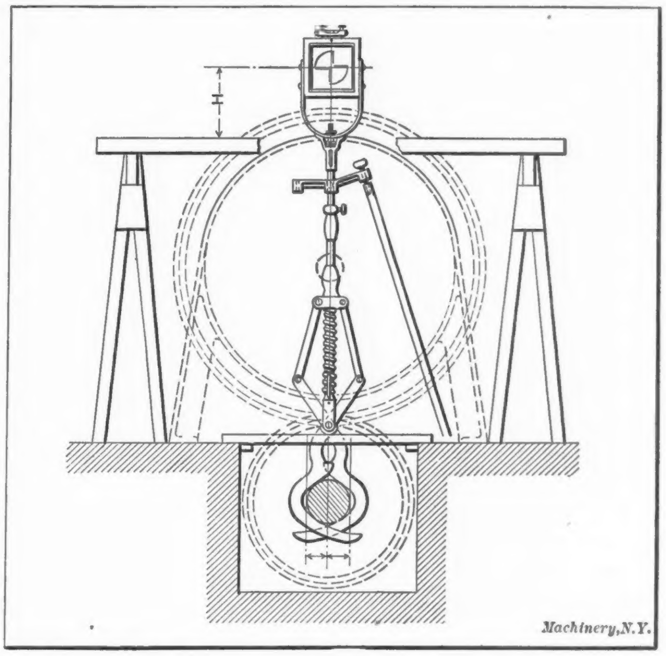


Fig. 2. Lining up Shafting carried in a Pit

The spirit level is attached to the face of the target by means of a special casting designed for the purpose. The target is supported by means of the rod shown, on which the adjustable thumb-screw rests.

It is common in a great many industries to arrange machines on benches, and drive them from a lineshaft beneath. For such work the arrangement shown in Fig. 4 may be employed. The portable target is mounted in fixtures which bring it at right angles with the clamping mechanism and bring it in a suitable place for working the architect's level and the fixed target.

All the various arrangements described provide for the accurate locating of both the level and the fixed target in positions convenient to the operator, and by means which permit

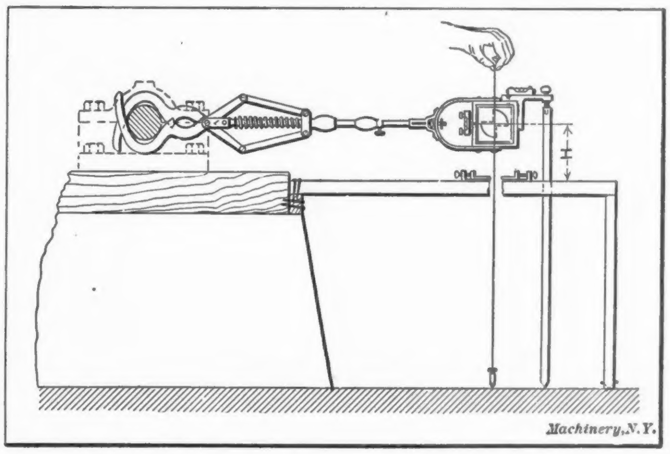


Fig. 3. Application to Shafting carried on Pillow Blocks

of the accurate alignment of the shafting. It will be remembered in connection with the former description that the jaws for gripping the shafting are so designed that they will clasp varying diameters without making any difference in the distance from the center line to the center of the target, as they automatically compensate for changes of diameter.

This equipment will be found useful in other ways. It may be employed for running lines of shafting through walls, or for setting up counter- or jack-shafts. It is also applicable to such jobs as the grading of steam and water pipes, the setting up of machinery, and the common problems in surveying

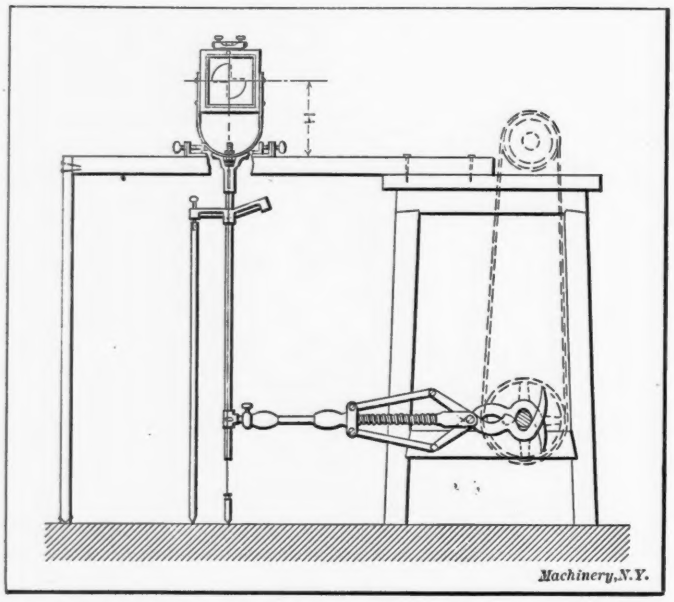


Fig. 4. Special Attachments for Lining up Shafting Mounted under the Bench

met with around manufacturing plants. This apparatus is now in use in many large and important mills and manufacturing establishments. It has been found that the accurate testing and maintenance of alignment in line shafting results in a surprisingly large saving of power, and the consequent avoidance of much trouble and expense.

PRENTICE 12-INCH GEARED HEAD REVERSING LATHE

The Prentice Bros. Co., of Worcester, Mass., has built for a number of years a geared head high-speed lathe, which has come into extensive use. The headstock provided with this lathe gives eight spindle speeds, any of which may be obtained while the lathe is in motion, since the changes are made by means of friction clutches of special design, operating without shock or danger to the gears. The arrangement is

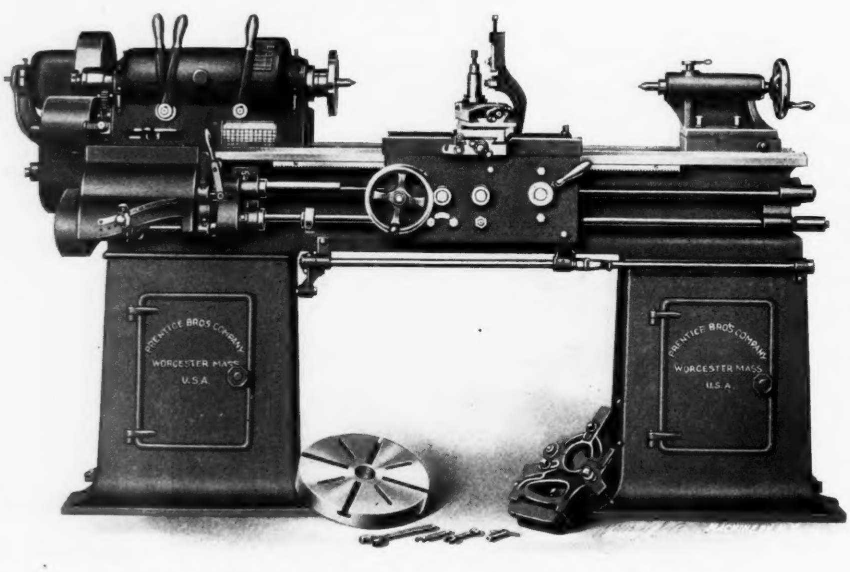


Fig. 1. Geared-head Prentice Lathe with Reversing Mechanism Incorporated

such that it is impossible to engage two conflicting gear ratios at the same time. The advantages of a constant speed pulley drive of this kind are now well understood, in the matter of giving a constant belt horsepower at any speed throughout the whole range. On this 12-inch swing machine, the belt has a capacity for about 10 horsepower when the countershaft is speeded at the proper rate of 400 revolutions per minute.

An improvement recently incorporated in the design of this machine is shown applied to the lathe in Fig. 1; it is illustrated in detail in Fig. 2. The improvement consists in doing away with the countershaft, by making the reversing mechanism a part of the headstock drive. This is located on the driving shaft and consists, as shown in Fig. 2, of three bevel gears and two friction clutches, together with a lever for operating them.

One bevel gear, *A*, is mounted on the hub of the driving pulley *B*, and when this is engaged to the driving shaft by clutch *C*, a forward movement is given to the spindle through driving shaft *D*. For reversing the spindle, clutch *C* is disengaged and *E* is engaged, so that the spindle movement in the opposite direction is transmitted through gears *A*, *F* and *G*. These bevel gears transmit power, it will be seen, only when the shaft is reversed for threading or similar work. The lever for operating this reversing mechanism is located on and travels with the apron, so that no matter how long the lathe bed may be, the operator always has immediate control of the starting, stopping and reversing of the lathe spindle.

With this reversing mechanism, the countershaft becomes unnecessary, thus saving the two pulleys, shaft, clutches and hangers usually required when using a double friction countershaft. Whenever it is convenient, the lathe may be located underneath line-shafting and belted directly to it.

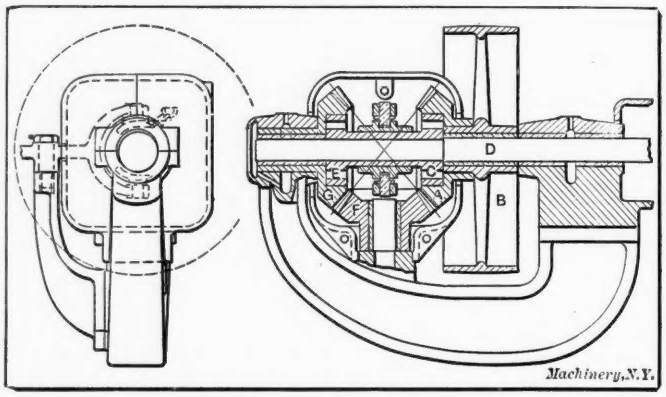


Fig. 2. Arrangement of Gearing and Clutches for Reversing

This construction also has advantages in the application of motor-drive to the lathe; the only additional mechanism that has to be furnished in this case is the motor itself. This is mounted on a bracket which is bolted to the rear side of the head-end cabinet leg. The motor is bolted directly to the driving pulley of the lathe. Provision is made for adjusting the height of the bracket and the tightness of the belt. One of the greatest objections to motor-driven lathes in the past has been the delay in obtaining the motors. This construction will do away with practically all trouble from this source, as any standard type may be used.

As mentioned, the lathe is practically of the same mechanical design as those previously built. It has, however, been redesigned throughout with the idea of making it heavier and capable of more severe service. The carriage is rigid, with an unusually stiff bridge, has a long bearing on the V's and is gibbed to the bed. The end thrust of the spindle is taken by a step bolted to the end of the headstock and entirely independent of the spindle bearing. A gear mechanism is furnished which permits the instantaneous change from one feed to another. There are 44 ratios available for screw cutting, ranging from 4 to 60 threads per inch. The index plate provided makes these changes so simple that an inexperienced hand can operate the mechanism without danger of mistake. An automatic stop to the feed is provided, which disengages a clutch on the feed rod at any desired length of cut.

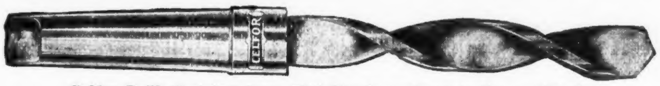
Large and small faceplates, center-rest and follow-rest, and

the required wrenches, are supplied with each lathe. When specified, the makers will supply at extra cost, taper attachment, countershaft (either of the tight or loose pulley styles) and electric motor attachment of any style or make of motor. The net weight of the machine with a 6-foot bed is 2,065 pounds.

CELFOR TAPER SHANK TWIST DRILL

The Celfor Tool Co., of Buchanan, Mich., has for some time past been supplying a drill made from a flat bar of high-speed steel. These drills are twisted while hot in especially designed machines. The resulting form has an increase of torsional strength of nearly 50 per cent over that of the flat bar from which it is made.

This drill has previously been left with the flat tang, and so has required a special form of drill chuck. The manufacturers are now, however, furnishing it with standard Morse

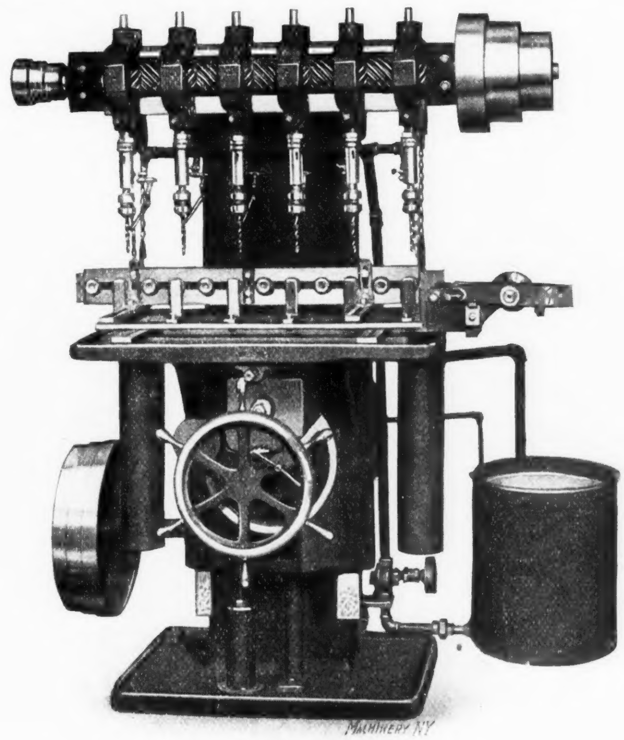


Celfor Drill, Twisted from Flat Stock, and set in Taper Shank

tapers, so that they can be used in the drill press spindle directly. The drills themselves, which are unchanged, are set into these taper shanks. The taper is one size larger than the standard employed for twist drills, so that ample driving power is assured, avoiding the difficulties met with in the failure of the tang on high duty work. As compared with the standard twist drill, the Celfor type is nearly twice as thick through the center, and has nearly 60 per cent more clearance space for the escape of chips. This results in requiring less operating power, owing to the relief from the clogging of the chips in a deep hole. The drills are accurately finished, being milled and ground in accordance with the best practice for such work.

MOLINE CONTINUOUS SIX-SPINDLE PIN DRILL

The machine shown herewith is made by the Moline Tool Co., Moline, Ill. It is designed especially for the rapid and economical drilling of cotter holes in brake pins, or for any



Six-spindle Drill with Shifting Work-holding Fixture

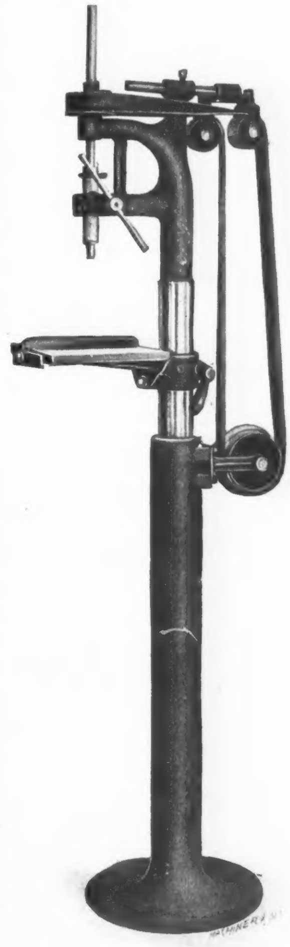
other similar work. Its special features are the provision of an adjustable jig for holding pins of different diameters and different lengths with precision, and also the arrangement for inserting and removing one set of parts while the others are being drilled. The machining operation is thus practically continuous.

The jig has twelve stations, while the machine has but six spindles. The operator places the pins to be drilled in every alternate station of the jig, which he then slides endwise to bring beneath the drill spindles, after which he starts the feed. While these are being drilled, the operator removes the work from the other stations and fills them again, ready to be shifted in their turn under the spindles as soon as the first lot is completed. The feed mechanism, as will be seen, is effected by a cam movement, so that the work-table drops instantly when the holes are drilled through. This movement is continuous, although it can be thrown out and the table lowered by hand if desired. There is an adjustable stop under the table so that it drops only far enough for the jig bushings to clear the drills. This can be dropped out of position and the table lowered clear down.

The spindle drive and the spindle head construction is along the lines of the regular multiple spindle drills made by this firm, and illustrated in connection with the fifty-eight spindle drill described elsewhere in this number. The spindles have ball thrust bearings and vertical adjustment for different lengths of drills. The machine is furnished with or without pump tank, piping, jigs and chucks. It may be used as a regular six-spindle adjustable drill when the special jig is removed.

TEN-INCH FLOOR DRILL

The bench sensitive drill press made by the Rockford Lathe & Drill Co., of Rockford, Ill., and described in the department of New Machinery and Tools of our number of November, 1909, is now furnished by the makers as a floor machine. The accompanying illustration shows it so arranged. It will be furnished with or without countershaft. It is provided with a belt-tightener and endless belt as shown. A tool-pan is mounted on the column, which does not appear in the engraving.



Ten-inch Sensitive Floor Drill

The spindle is 17 inches long and ¾ inch diameter. It is provided with a lever feed of 3 inches. The table has a surface of 8 by 8 inches and a vertical adjustment of 9 inches. The greatest distance from the spindle to the table is 12 inches. The driving pulley on the countershaft is 5 inches in diameter, 1⅝-inch face, and should run 550 revolutions per minute.

The advantages of the swiveling and tilting table and adjustable gage, furnished with this machine, have been described in connection with previous designs.

FRITZ "IDEAL" DRAFTING TABLE

The Fritz Mfg. Co., of 60 Alabama St., Grand Rapids, Mich., builds a line of drafting tables designated as the "Ideal," which is intended to meet the demand of draftsmen, students, etc., who need a good piece of furniture at a reasonable price. The construction is designed to be strong, durable and unusually rigid.

The standards are slotted and the cross-bar is tenoned into the slot. The cross bar is bored its full length for a rod, carrying a hand nut at one end, by means of which the legs are clamped in place. By loosening this adjustment the table

may be raised or lowered. When the nut is turned up, the table is held firm and rigid and does not allow the slightest vibration. The table can be tilted from a vertical to a horizontal position. This is effected by metal slides and braces. After the adjustment, it is clamped at both sides by a single thumb-nut at the right-hand side.

A Rigid and Inexpensive Drafting Table

When desired, a carefully finished tool cabinet will be furnished. This cabinet is provided with two drawers, the upper one of which may be drawn out to be used as a tray. These drawers are 6 by 20 inches; the upper one is two inches deep, and the lower three inches deep, inside measurement.

The frame of the table is of hard wood. The top is ordinarily made of soft wood, but for the smallest size (22 by 30 inches it will be furnished in hard wood if desired. Four sizes are made, ranging up to 37 by 48 inches.

KEMPSMITH NEW UNIVERSAL DIVIDING HEAD

One of the most important accessories used with a milling machine is the universal dividing head, and many considerations must be taken into account in its construction. The dividing head is used frequently and on greatly varying classes of work, and the work done must, as a rule, be accurate. It is, therefore, necessary that the dividing head be carefully designed and accurately made; at the same time it must be of such construction that the requisite strength is provided. The accuracy must be preserved, facilities for proper adjustments must be included, and when in use it must be convenient to handle and operate, as well as universal in its scope.

An improved universal dividing head as illustrated in the accompanying half-tone, Fig. 1, has recently been brought out by the Kempsmith Mfg. Co., Milwaukee, Wis. In the design of this dividing head the various considerations referred to above have been given due attention. The dividing head is substantial and compact in its construction, and there is a notable absence of complicated mechanism.

Dividing Mechanism

It is evident that the most important feature of any dividing head is the dividing mechanism, and a large diameter of the worm-wheel is essential for accuracy. The usual method employed for making the worm-wheel of large diameter is to mount it at the extreme end of the spindle, practically outside of the main frame. This method, however, is objectionable because it brings the working strain on one end of the spindle, and the worm-wheel casing is in the way when work is to be done close to the head. On the dividing head shown in the illustrations, the worm-wheel is mounted centrally inside of the head, between the front and rear spindle bearings. It is pressed on the spindle and keyed, thus insuring a positive movement of the spindle when the wheel is engaged by the worm. The angular position has been adopted for the worm-shaft. It is at an angle of 36 degrees with the horizontal, which brings the point of contact of worm and worm-wheel correspondingly around at an angle with the vertical. This arrangement makes it possible to increase the diameter of the worm-wheel because the angular position of the worm-shaft and index plates avoids interference of the latter with the table. In the head of 10½ inches swing, the diameter of the worm-wheel is 5¼ inches, and in the head of 13¼ inches swing, the diameter is 6½ inches. Fig. 2 shows the rotating arm or block with the spindle and worm-wheel in place, and Fig. 3 the spindle and worm-wheel assembled. In Fig. 4 is shown a horizontal and vertical section of the dividing head, giving a general idea of its design.

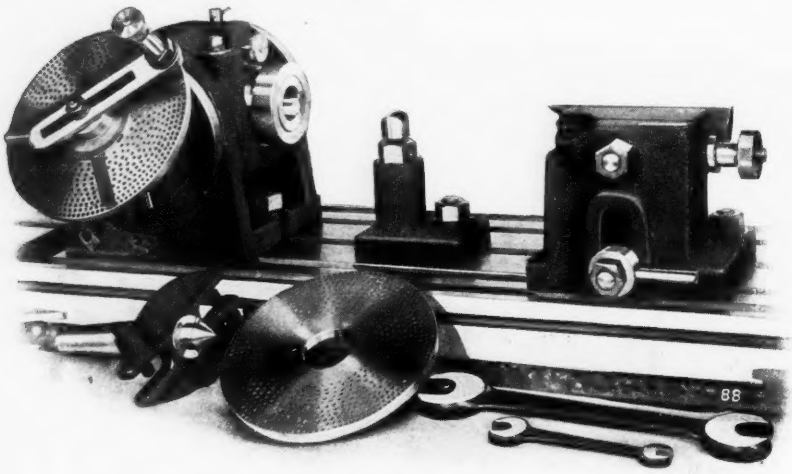


Fig. 1. New Type of Universal Dividing Head, brought out by the Kempsmith Manufacturing Co., Milwaukee, Wis.

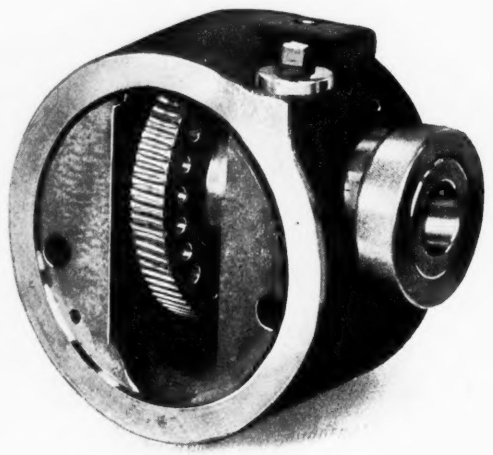


Fig. 2. Rotating Block of Kempsmith Dividing Head

As will be seen, the worm is in one piece with the worm-shaft, which is mounted in a long bearing extending up to the shoulder formed by the worm itself. This arrangement provides for a strong bearing support close to the point of contact between the worm and the worm-wheel. The worm runs in oil, the oil pocket being shown in Fig. 3 and in the vertical section of Fig. 4. An outside adjusting screw is provided by means of which the wear between the worm and worm-wheel is taken up. This adjustment is in a straight line, perpendicular to the axis of the worm-wheel, and thus preserves the alignment and accuracy, even after repeated adjustments. When direct rapid indexing is required, the worm can be

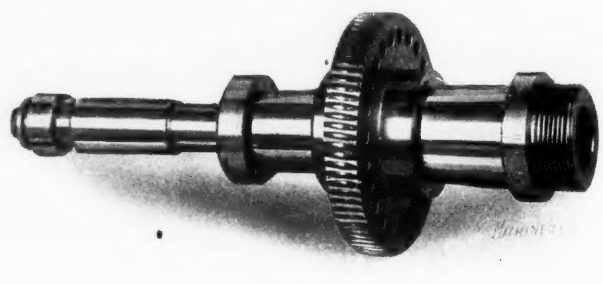


Fig. 3. Dividing Head Spindle and Worm-wheel Assembled

easily disengaged from the worm-wheel. The arrangement for disengagement is entirely independent of the adjustment, so that this latter is not disturbed. Another advantage of the disengagement is that when tightening the nut on arbors put into the spindle, the worm-wheel teeth do not take the stress.

Range of Index Plates

Two index plates are regularly furnished, providing divisions for all numbers up to 60, and for all even numbers and all multiples of 5 up to 120, and a very liberal number of divisions between 120 and 400. Three specially high number index plates can also be furnished, providing 122 additional divisions between 61 and 400. These plates include all divisions up to 200, which are not obtained by the standard index plates. The arrangement of mounting the index plate at an angle permits of still larger plates being used, if for any extremely special case this should be required, without it being

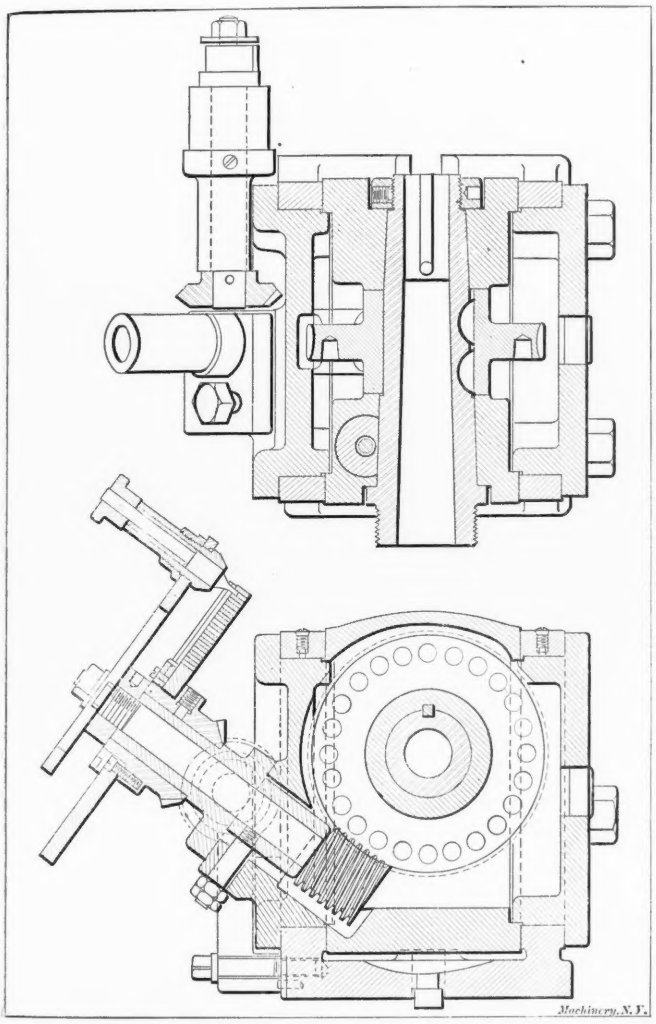


Fig. 4. Horizontal and Vertical Sections of Dividing Head

necessary to increase the swing of the dividing head to provide room for the larger plate.

The index handle is mounted directly on the worm-shaft as shown in Fig. 5, so that its movements are directly transferred to the worm-wheel, leaving no chance for error or inaccuracy through a train of gears. The angular location of the index plate makes it much easier for the operator to see it clearly when indexing, because it is directly in his line of vision as he stands in his natural operating position. It is not required that he stoop down, as in the case when the index plate is vertical.

Direct indexing is easily accomplished with the worm and worm-wheel disengaged. A plunger engages a circle of holes in the front of the worm wheel, as shown in the vertical section of Fig. 4. The spindle is graduated correspondingly on the front of the shoulder, so that the movements can be easily determined. This quick indexing is valuable for small numbers of divisions—for example, when milling hexagons, or the flutes in taps or reamers.

Spindle and Rotating Block

The spindle is of liberal diameter and is mounted in taper bearings provided with a simple but efficient locking device, as indicated by the clamping bushing in the horizontal section in Fig. 4. The taper hole and the threaded nose on the index

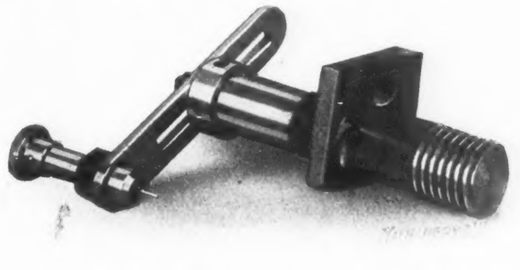


Fig. 5. Worm and Worm-shaft with Index Handle

head spindle are the same as on the main spindle of the milling machine with which the dividing head is regularly furnished. Thus all tools are interchangeable between the main spindle and the dividing head. A large hole runs clear through the spindle. The rear end is arranged to receive an extension stud which is used when the spindle is geared di-

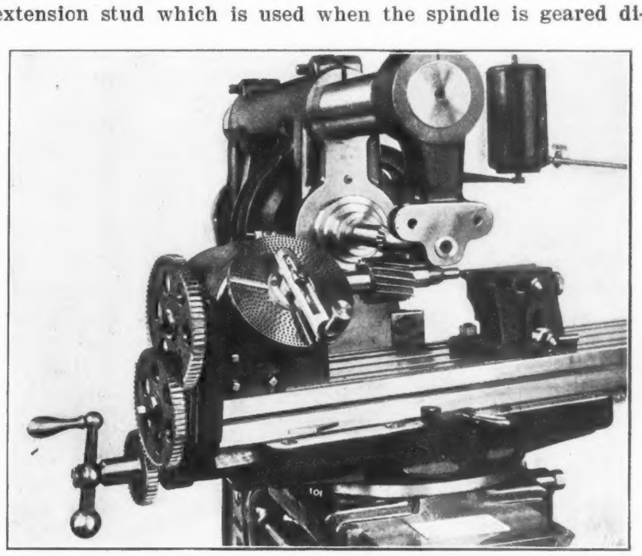


Fig. 6. Dividing Head arranged for Spiral Milling

rectly to the feed-screw. This arrangement is used when cutting spirals of very short leads as will be mentioned later. This stud is shown in place in Fig. 3. The rotating block which carries the spindle is capable of swinging through an arc of 150 degrees, from 10 degrees below the horizontal to 50 degrees beyond the perpendicular. It is firmly clamped in

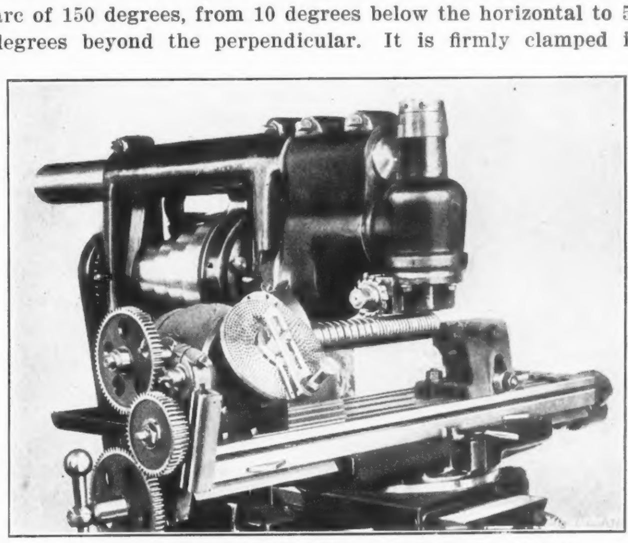


Fig. 7. Feed-screw Geared Directly to Index Head Spindle

whatever position set by means of two large bolts with hexagon heads placed in the rear of the head.

Change Gears for Spiral Milling

Twelve change gears are furnished with the dividing head for spiral milling. The change gear bracket is quickly attached or removed. The drive from the change gearing to the

worm-wheel is through two miter gears, one being on the same stud as the last gear in the change gear train, and the other being attached directly to the index plate. In Fig. 6 is shown the dividing head arranged with a train of change gears in the usual manner for cutting a spiral, the work in this case being a spiral milling cutter three inches in diameter, 18 teeth, with 48-inch lead of spiral. When the lead is less than 1½ inch, the gear ratios become so high that too much

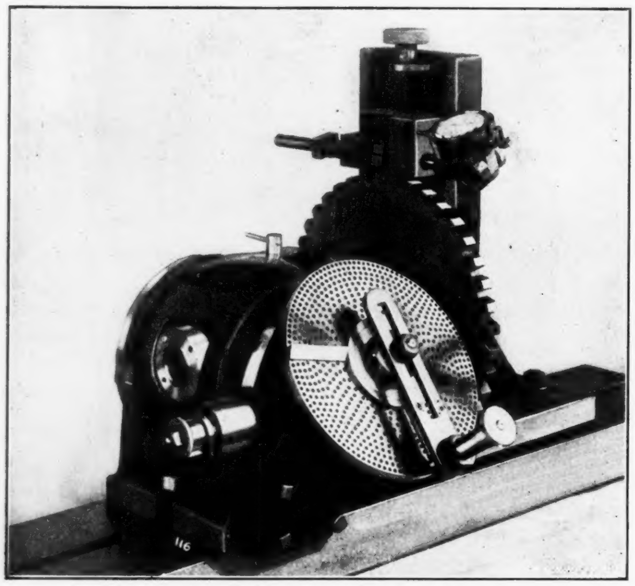


Fig. 8. Testing the Worm-wheel

power is consumed in transmission and these leads, therefore, cannot be cut in the usual manner. A very interesting method is, therefore, used for short leads, in that the gear train is led directly from the feed-screw to the dividing head spindle, as already mentioned, the extension stud being provided on the spindle for this purpose. A gearing arrangement of this kind is shown in Fig. 7, which also shows the use of the universal milling attachment when the angle between the cutter and the work is greater than that which can be obtained through the swiveling table. In the

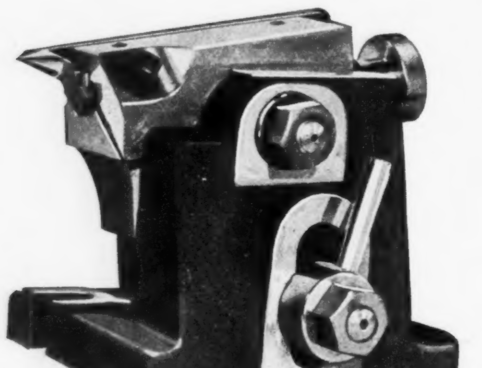


Fig. 9. Tailstock of Kempsmith Dividing Head

charts which accompany the dividing head, the gears required for leads from 0.120 to 1.500 inch are given for direct gearing, and for leads from 1.550 to 100 inches for gearing in the ordinary manner.

Testing the Worm-wheel

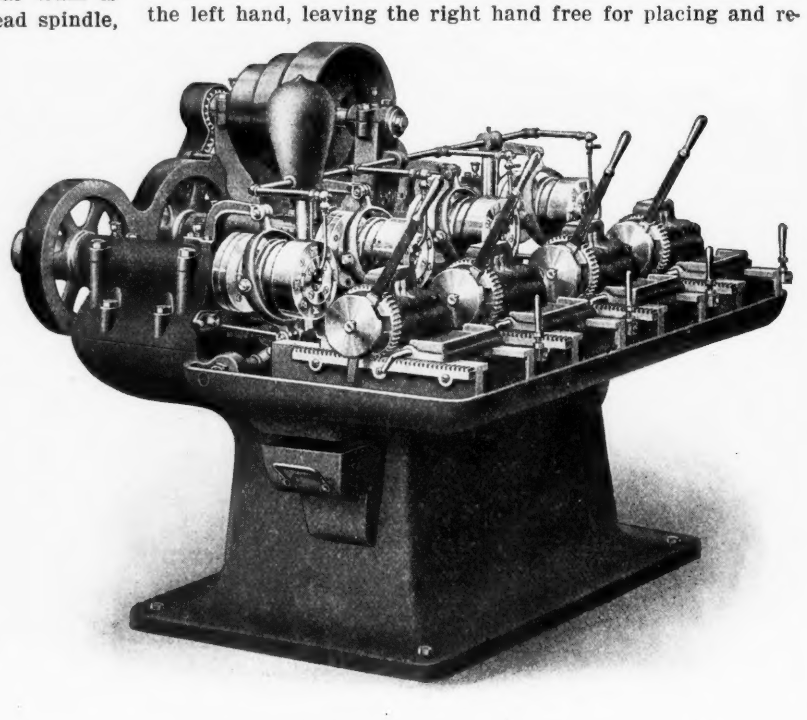
The method employed in testing the accuracy of every tooth in the worm-wheel may be of interest, and is shown in Fig. 8. The master plate is mounted in the spindle. This plate has 40 perfect divisions, and, therefore, makes it possible to test the relative and cumulative error for the individual teeth. The maximum relative error allowed on the master plate itself is 0.0005 inch, and the maximum cumulative error at any point on the master plate is 0.002 inch. The average is less than one-half of this. The master plate is 11 inches in diameter and the worm-wheel for the 10½-inch swing head, 5¼ inches, as already mentioned; hence errors on the master plate are correspondingly reduced on the worm-wheel proper.

The Tail-stock

The tail-stock is of the side center type and is shown in Fig. 9. The center is set into the tail-stock at an angle so that the actual center is within ⅛ inch of the inner side of the tail-stock and within ⅛ inch of the top. This arrangement is of great importance as it provides for clearance for cutters and makes it possible to use much larger cutters on many classes of work than would otherwise be possible. This, again, often effectually increases the output of the machine in such instances. The center, by a special arrangement, as indicated in Fig. 9, is firmly fixed in the tail-stock, and a rapid and easy adjustment is provided. A rack and pinion furnish means by which it can be elevated for milling tapers, after which it can be tilted and clamped in alignment with the work.

NATIONAL QUADRUPLE-SPINDLE BOLT CUTTER

The National Machinery Co., of Tiffin, Ohio, is building the four-spindle bolt cutter illustrated herewith. This is provided with the makers' standard opening die and is built in several different sizes. The convenient design of this machine makes it possible for a workman, where the thread is of reasonable length, to feed all four spindles with as little loss of time as when handling the ordinary single or double spindle bolt cutters. A patented single lever vise and carriage movement is used, which enables him to control the carriage and the gripping of the work with a single lever. This is operated with the left hand, leaving the right hand free for placing and removing the work in the vise. The machine is thus particularly adapted to large lots with comparatively long lengths of thread.



National Quadruple-spindle Bolt Cutter

A combined automatic and hand opening and closing device for each head will be furnished, and these heads can be run independently or in unison. The drive is furnished by a three-step cone pulley, placed on top of the machine. This reduces the floor space, enables the shaft to be supported at both ends, and keeps the belt free from grease and chips. The die heads provided on the machine are self-contained, and do not depend on outside mechanism to control the locked position. This makes the head practically a solid die when closed, insuring accuracy in the product. The makers' interchange-

able case dies are used. The machine has a forced-feed lubricating pump, with adjustable stroke for regulating the flow.

WALKER "SINGLE STROKE" SURFACE GRINDER

The accompanying engravings illustrate a very attractive design of rotary surface grinder of the cup wheel type, made by the Walker Grinder Co., Worcester, Mass. This machine differs from other cup wheel surface grinders in that no reciprocating movement is provided for, the work being mounted on a rotary magnetic chuck, while the wheel is fed straight down against it until it has been finished to the proper thickness. It thus has a large field in the accurate surfacing and sizing of such parts as piston rings, thrust collars, small dies, milling saws and other work of a like nature.

General Design

The general design of the machine comprises a stiff column of vertical form, provided with two vertical slides, the lower of which carries the rotating wheel-spindle, which is adjustable for height to give the desired thickness of work; the upper or wheel-slide carries the wheel-spindle, and is fed down against a positive stop to obtain the proper thickness in the parts being ground. A single pulley drive is employed which provides power for all the movements of the machine, and makes it easily adaptable to motor driving. Two work-spindle speeds are furnished. The single lever which controls

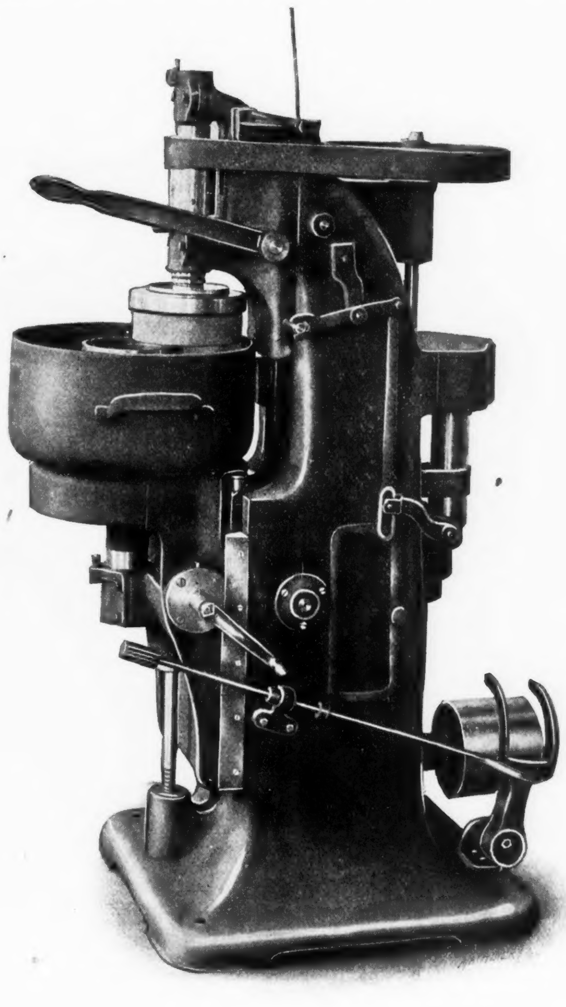


Fig. 1. A Rotary Surface Grinder, provided with Magnetic Chuck

the feeding movement of the wheel-spindle slide also operates to control the starting and stopping of the work-spindle, the switching on or off of the magnetizing current for the chuck, and the control of a demagnetizing current for eliminating the residual magnetism, to permit the work to be removed easily and without scratching. These last features are recent inventions of Mr. Walker, which will be described further on. Their use, in combination with the other improvements furnished, has made possible the rapid manipulation of the machine, and, consequently, gives it a very high output.

The Driving Mechanism

The details of the construction are best shown in Fig. 3, which should be studied in connection with the elevations in Figs. 1 and 2. The tight and loose driving pulleys are shown at *A*. A belt shifter is provided whose handle extends forward to the operator's working position. The pulley *B*, inside

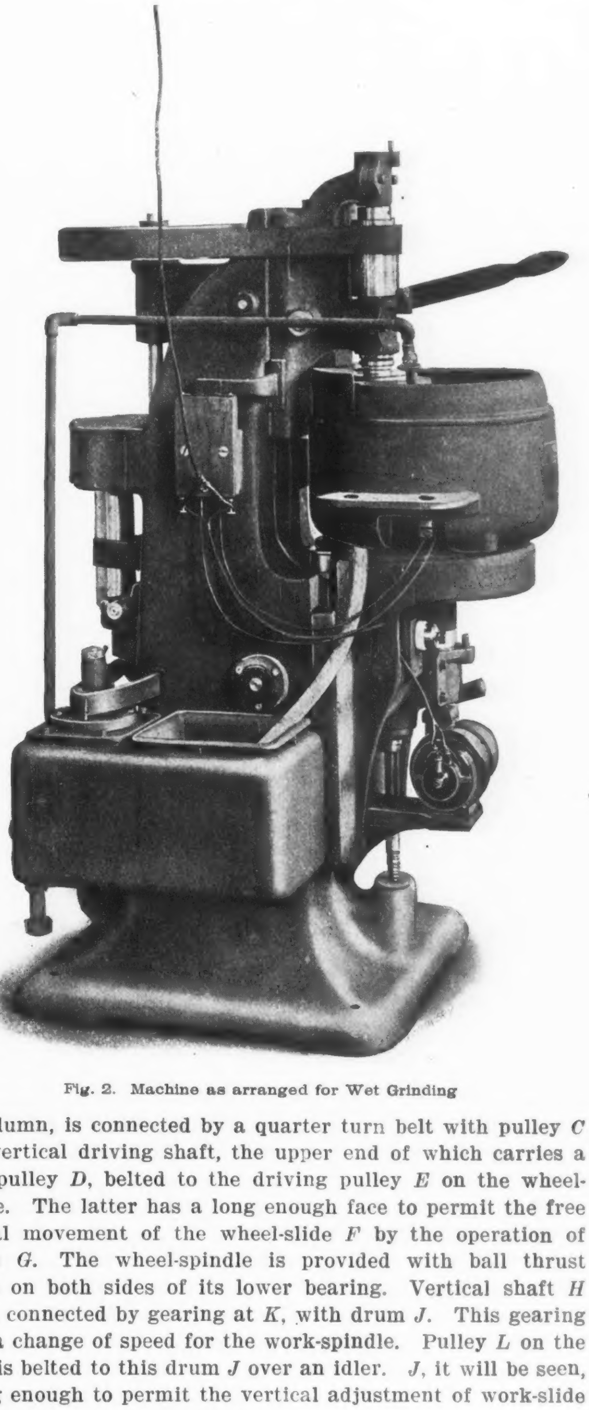


Fig. 2. Machine as arranged for Wet Grinding

the column, is connected by a quarter turn belt with pulley *C* on a vertical driving shaft, the upper end of which carries a large pulley *D*, belted to the driving pulley *E* on the wheel-spindle. The latter has a long enough face to permit the free vertical movement of the wheel-slide *F* by the operation of handle *G*. The wheel-spindle is provided with ball thrust collars on both sides of its lower bearing. Vertical shaft *H* is also connected by gearing at *K*, with drum *J*. This gearing gives a change of speed for the work-spindle. Pulley *L* on the latter is belted to this drum *J* over an idler. *J*, it will be seen, is long enough to permit the vertical adjustment of work-slide *M* throughout its whole range.

The Automatic Control of Work-spindle Drive, Magnetizing Current, etc.

The grinding wheel *N* is brought down to the work and is fed against it by the operation of hand lever *G* and the rack and pinion movement connected therewith. The positive stop which limits this downward movement is shown at *O*. This wheel-slide is counterbalanced by a weight inside the column, as shown, so that when the handle is released it returns to its upper position, leaving plenty of room under the wheel for the easy placing and removal of the work. The link and lever connections shown at *P* connect the wheel-slide *F* with a jaw clutch inside of drum *J*, disconnecting the latter from the shaft on which it is mounted when slide *F* is in the upper

position. By this means the work-spindle is automatically stopped whenever the wheel is raised from the work.

The automatic control of the magnetizing current is effected by a switch mechanism enclosed in the casing shown at the side of the frame in Fig. 1. The wheel-slide carries an arm provided with electrical contacts, which slide over corresponding contacts in the switch box. In the lowermost position, when the wheel is pressed against the work, the direct current is flowing through the chuck. As the wheel is withdrawn, this contact is broken and a new one is made, sending a demagnetizing current through the coils of the chuck. In the final upper position of the slide, the chuck is entirely disconnected from the current, leaving it free for the removal of the work.

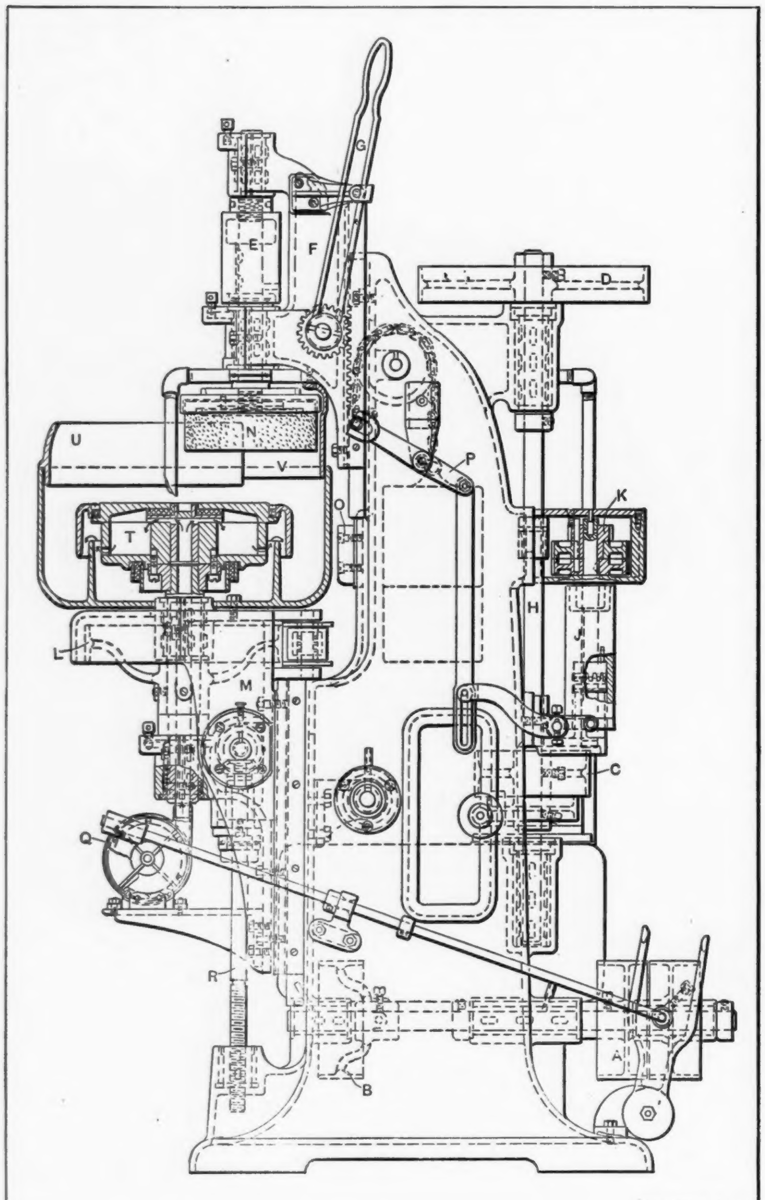


Fig. 3. Details of the Driving and Feeding Mechanism

The Work-spindle and its Slide

As explained, the wheel-spindle slide is brought down each time to a positive stop. The adjustment for thickness of the work is therefore obtained by raising or lowering the work-spindle slide *M*, by means of the crank shown at the side of this slide in Fig. 1 and connected with elevating screw *R* in Fig. 3. When this adjustment is once made, it holds for successive operations, except as it is affected by the wear of the wheel. For this, compensation is made by the gradual raising of the work-spindle slide. The slide is very long in proportion to its overhang, so that there is little elasticity or lost motion.

Special Provisions for Wet Grinding

Fig. 2 shows the machine as arranged for wet grinding, and Fig. 1 for dry grinding. It will be noted that besides the provision of the standard type of centrifugal pump, reservoir and piping, a blower at the lower end of the work-spindle has been furnished. The purpose and construction of this is most plainly shown in Fig. 3, where it is shown at *Q*. It is driven, as shown, by a direct connected motor, and exhausts into the hollow work-spindle, where the current of air is forced through its whole length up into the interior of the chuck, through the magnet coils, and out under the guards into the water space. This current of air effectively prevents moisture from getting into the coils, and thus obviates any difficulty arising from cross-circuits or other electrical troubles, which are otherwise difficult to avoid where a flood of water is employed. Guard *U*, fixed to the lower slide, and *V*, attached to the upper one, keep the water from flying over the machine and operator.

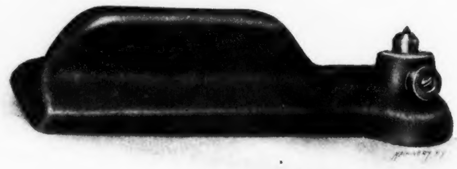


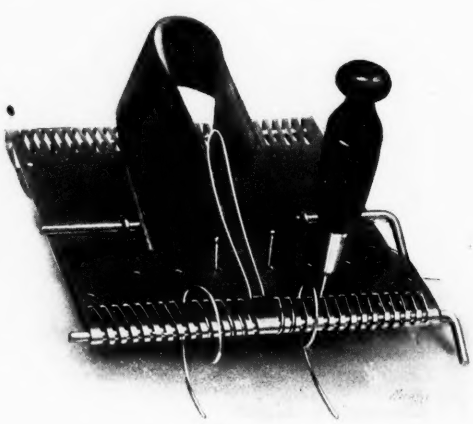
Fig. 4. Tool for Truing, which permits Adjustment of Carbon to present Fresh Cutting Edges

Truing Device for the Wheel

One of the difficulties met with on this style of grinder is the use of the diamond in truing the wheel. The surface of the wheel must obviously be kept true and parallel with the chuck face. To secure this it is necessary that the diamond be mounted in a holder which slides on the chuck face or platen, underneath the wheel. It will be seen that with this arrangement, the wear must necessarily come in one place on the carbon, resulting in a gradual flattening of the cutting edge, and the consequent glazing of the wheel.

Fig. 4 shows an improved carbon truer designed to overcome these objections. In this device the stone is set in a shouldered stem, fitted in the top of a flat holder. This stem is set at a considerable angle from the vertical. With this arrangement, when a flat spot has been worn on the carbon, the stem can be swiveled slightly and fastened in a new position, thus providing a means of obtaining new cutting points on the carbon and a keen cutting surface on the grinding wheel. Means are also provided for disconnecting the automatic switch so that both the magnetizing and the demagnetizing currents are cut off, allowing the free manipulation of the carbon holder when truing the wheel.

The diameter of the wheel is 8 inches, and that of the chuck is 10 inches. By reason of the provision of the magnetic chuck, a large number of small pieces may be held at once, making the machine especially suitable for rapid and accurate manufacturing.



An Inexpensive Outfit for Wire Belt Lacing

MUMFORD WIRE HINGE BELT LACING DEVICE

In the department of New Machinery and Tools of the July, 1909, number of MACHINERY, we illustrated a belt-lacing device made by the Mumford Mfg. and Supply Co., 258 West 22nd St., New York City. This device makes a lacing of the type in which a coil of wire is threaded through each end of the belt. When these coils are interlocked a raw-hide pin is drawn between them, forming the hinged wire belt lacing which has become so largely used on account of its efficiency and durability.

The improvements in the device consist in making provision for both single and double belts and in avoiding the necessity for turning the templet over for lacing the opposite ends of the belt. The way in which these improvements are made will appear from the description. The templet is fastened to the bench in any convenient way. As shown, it is done by staples which project through slots in the plate, and it is locked by a wire rod passing through the staples. The end of the belt is inserted in the turned-up front of the templet, where it is held by lightly driving in one or two wire nails as shown. The slots serve to guide the workman in making the holes with the awl, and in threading the wire through them with a pair of pliers. The wire lacing is threaded over a mandrel placed in the templet in front of the belt as shown.

It will be noted that the slots run right-hand on one side of the center and left-hand on the other. For narrow belts, such as that shown in the engraving, the belt may be doubled back so that both ends are laced at once, one of them right-hand and the other left, allowing the laced ends to interlock properly. Wide belts should be placed in the templet evenly spaced on each side of the center line, so that half of the lacing is right-hand and the other left-hand. When the other end is placed in the similarly laced templet the other side up the two ends will interlock. The original construction provided right-hand slots at one end of the templet and left-hand ones at the other end, necessitating a reversal for each operation. In this improved construction the templet at one end provides for single thickness belts and for double thickness at the other. The slots for the latter are alternately long and short, allowing for staggered lacing.

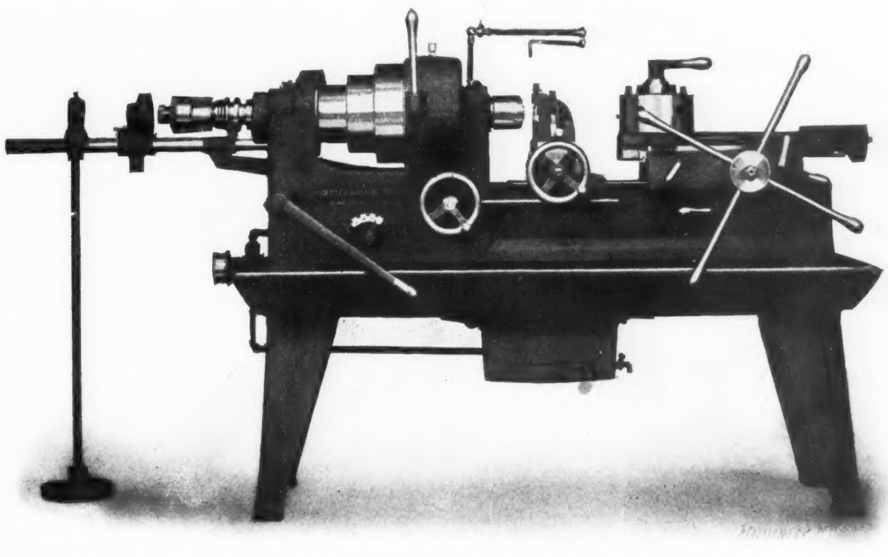
While the device has a width of only 6 inches, it may be used on any width of belt by shifting from one position to another. It is the only tool of its kind which can be used for a belt wider than itself. As previously described, the equipment comprises the templet, the necessary mandrels, an awl, pliers, and a supply of wire and raw-hide pins.

DRESES POWER FEED SCREW MACHINE

The illustration shows a very complete screw machine made by the Dreses Machine Tool Co., Cincinnati, O. This machine is provided with an automatic chuck and wire feed, friction back-gears, positive quick-change feed gearing, power feed for turret slide, separately adjusted automatic stop for each hole in the turret, and fine longitudinal adjustment for cross-slide. The facilities thus provided, in combination with the general excellence of design and workmanship, produce a machine which should be well adapted to a wide range of manufacturing work.

The headstock and bed are cast in one piece, and the design of the headstock provides within itself for the adequate protection of the feed and back-gearing. The spindle is driven by a three-step cone. The frictions for the back gears are of the toggle-joint type, and are so designed that the entire operating mechanism can be put in place or removed without taking out the spindle. These clutches are powerful, easily adjusted and noiseless in operation. The spindle bearings are of the highest grade of babbitt metal, upset into their seats. The nose of the spindle is of an improved construction which provides two blank cylindrical portions each side of the thread, fitting the thimble or faceplate of the chuck. There is no bearing on the thread itself, which merely serves to hold the chuck on and does not in any way affect the alignment. The nose is made very short to bring the work close to the spindle bearing. The thrust is taken up against the inner rear housing of the head, allowing play in the front bearing for the elongation of the spindle from temperature changes. This also reduces the overhang and the length of the front bearing, compared with what would be necessary if the thrust were taken up at that point.

The standard design of chuck and stock-feeding device is used, but special attention has been given to simplifying the operating mechanism, and arranging it for convenient handling. The operating lever, as will be seen, is placed in a position where the workman can exercise the greatest force with the least exertion. The split hub and clamp nut provide for changing the position of this lever to agree with the build or strength of the operator. It will be noted that the thimble for spreading the chuck fingers at the rear end of the spindle is provided with steps, which permit of a considerable variation in the diameter of the stock used without requiring the machine to be stopped for readjustment.



Dreses Screw Machine with Improved Friction Head, Geared Feed and Multiple Stops

The turret has an index ring of as nearly the full diameter as is practicable. A long square gibbed locking bolt holds it firmly into position. By the construction employed, the wearing surface of the turret and slide is not interrupted by the locking bolt, and no particle of metal from the wear of this member in its seat can abrade the surface. Provision is made for taking up the wear of the turret on its stem.

The turret slide is provided with a series of six stops, one for each hole in the turret, mounted on a bracket in the turret slide base. An abutment on the turret slide is provided, which is shifted from one of these stops to the other by a cam placed on the bottom of the turret. This abutment or stop dog makes about one-quarter revolution between the extremes of its movement. By means of an automatic locking plug, it may be instantly put out of action so as to clear all six stops. The bracket in which the stop screws are placed slides in a dove-tail on the turret slide bed. When the stop dog strikes one of the screws, it moves this bracket forward, knocking off the power feed. A slight additional movement can be given it by the pilot wheel for taking a finishing cut on a shoulder, and for cleaning out the chip left by the tool. A geared power feed of four changes is placed in the rear of the bed, and the changes are controlled by the small crank-handle shown beneath the headstock.

The cutting-off rest has a fine longitudinal adjustment on the bed by means of the handwheel, bevel gears and adjust-

ing screw shown. The cross-feed screw is provided with a graduated dial on the handwheel hub. The toolposts are of an improved design. They are open at the left-hand side, permitting them to be adjusted close to the face of the chuck. The wedges under the tools have a single dove-tail to keep them back in position, and knurled thumb-screws are provided for shifting them to adjust the tools to height.

Provision for a large supply of cutting oil or compound is provided by the very deep pan, mounted under the bed of the machine. The oil reservoir is hinged to the pan so that it can be readily cleaned. The inside is provided with two chambers, in the first of which the grit and dirt is separated and deposited before passing into the second or supply chamber, where the pump suction is placed. The leg at the small end of the table is provided with a hinge-joint, so that the machine rests, in effect, on a three-point bearing support, and the alignment is not disturbed by irregularities in the pull.

The tool weighs about 2,600 pounds. It is built in three sizes to take 1, 1½ and 2¼ inches through the wire feed. The illustration shows the 1½-inch machine.

ONEIDA STEEL-REINFORCED INDEPENDENT CHUCK

The line of four-jaw independent chucks made by the Oneida National Chuck Co., of Oneida, N. Y., has recently been greatly improved by an ingenious and inexpensive improvement, the nature of which will be readily understood from an examination of Figs. 1 and 2. This improvement consists in furnishing a steel reinforcement for the cast-iron body of the chuck, so located as to receive the tensile stress imposed by the tightening of the jaws on the work, and at the same time furnish a durable steel seat for the thrust bearing of the screws.

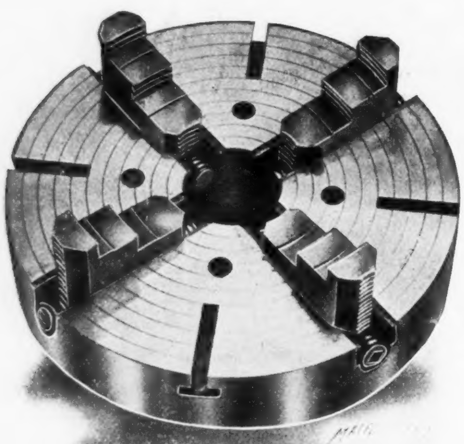


Fig. 1. Independent Chuck, Reinforced for Tensile Strains with a Steel Ring

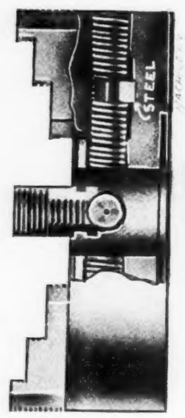


Fig. 2. Showing Steel Ring Cast into Iron Body

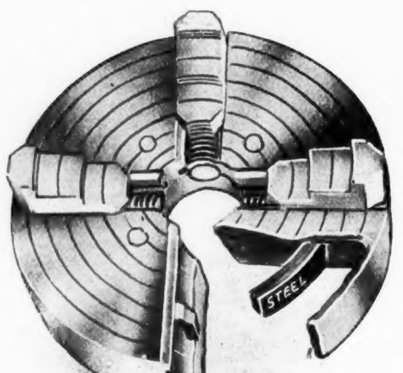
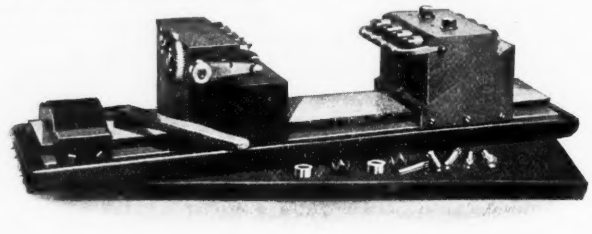


Fig. 3. Showing Location of Reinforcement at Screw Thrust Bearing

The interesting point in this construction is the way in which the steel is located in place in casting. The steel reinforcement is made in the form of an electrically welded ring of bar stock, which is centered in the mold when the chuck body is cast. When the iron is poured it surrounds this steel ring and incorporates it in the casting. Thus no fitting or machining or extra trouble has to be taken at all in the construction. The various machining operations are gone through with as before, and the added expense of the reinforcement is, consequently, negligible. When the chuck is completed, however, the steel bearing surfaces and the steel ring will be found in their proper places to take care of the tensile forces and to furnish the step bearing for the screw.

Fig. 2 best shows the effect of the ring chuck. It ties the body together, as will be seen. All disruptive strain, due to the tightening down of the jaws, is received by the steel in tension, thus relieving and reinforcing the iron, which is notoriously weak for a stress of this kind. Fig. 3 shows most plainly the way in which the thrust bearing is reinforced by the ring, which gives added durability at this point.

The chuck itself is of high-grade construction, with steel operating screws and jaws properly tempered and hardened. The screws, having a center bearing for the end thrust, are threaded to the extreme outer and inner end, giving the jaws the greatest possible capacity for large diameters. Owing to the reinforcement, it is possible to provide a deep seat for the jaws in the body, giving them unusual resisting power to strains tending to overturn them. The enlarged bearing area thus provided also adds very materially to the length of the useful life of the tool.



Four Spindle Index Head Designed for Rapid Manipulation and Convenient Adjustment

Three sizes of this chuck are now in stock, the 10-, 12- and 14-inch, and it is expected to have all sizes ready shortly after February 1. Inasmuch as this improvement is so inexpensive as not to add to the cost of the chuck, its advantages to the purchaser are obvious.

BICKFORD & WASHBURN FOUR-SPINDLE INDEX CENTERS

The tap and reamer fluting device herewith illustrated is made by Bickford & Washburn, 12 Chapman Street, Greenfield, Mass. It is an apparatus of simple construction for a common operation, and is one of a large number of similar devices which have been in use for many years. In spite of the fact that the purpose of the tool is not new, however, we think it will be agreed, after examination, that the designers have succeeded in incorporating a number of new and valuable features in its construction.

The tool comprises a base provided with a dove-tail slide, on which are mounted a tailstock adjustable for height, a headstock carrying the indexing mechanism, and a clamping block and lever for locking the work in place. This base, with the parts mounted thereon, is clamped bodily in place on the table of the milling machine, so that the device is handled as a single unit.

The headstock contains four spindles, connected together by spur gearing so that they are indexed in unison. The front spindle has mounted on it a bevel gear, meshing with a bevel pinion, which latter is provided with a crank and mounted in a bracket attached to the front of the headstock. One revolution of this crank or handle indexes the work between each cut. By changes in the gearing, 3, 4, 5, 6, 7 or 8 cuts may be taken, and a corresponding number of flutes given to the tap

or reamer. The changes in indexing are made by using different bevel pinions to engage with the large bevel gear on the first spindle. One of these pinions is shown in place in the machine and five more are lying on the bench in front of it. The large bevel gear has seventy teeth cut on one side and seventy-two on the other, further extending the range of indexing mentioned. The fact that the index crank is turned exactly one revolution, whatever the number of flutes being cut, is one of the good points of the design, as it makes mistakes in indexing impossible.

The work is held between drivers on the headstock spindles and center points on tailstock spindles. Two forms of these drivers, one for square and the other for round shanks, are shown on the bench in front. The squared ends are driven by the socket shown with square tapered holes, while round work is held and driven by the prong type of driver.

The headstock is a close sliding fit on the dove-tailed base, and it is moved in for clamping, or withdrawn for releasing by the operation of a toggle joint connected with the handle shown. The thrust is taken against the fixed block clamped to the left-hand end of the slide. The tailstock centers are each backed by heavy coiled spring, the strength of whose compression is adjustable by means of the screws and lock nuts shown at the rear of the block. As the headstock is pressed forward by the clamping lever, the blanks are brought up against the spring-supported tail centers to a greater or less degree, depending on the over-all length of the pieces of work. This spring pressure has the advantage over a positive abutment of taking up the looseness which results from the pressing together of the drivers and work at the headstock end under the thrust of the cut. The center points on the tail-stock are easily renewed in case of wear or accident.

Attention should be callea to the means provided for facilitating the removal and insertion of the work. When the headstock is drawn back, the work, while still confined by the drivers at the left-hand end, drops off the tail centers into the notches on the support shown, whence they may be lifted out all together with one hand. In putting the work in the machine this support serves the same purpose, as the blanks are placed in the drivers at one end and dropped into the notches on the support at the other, which brings the center holes at the right height for the tool centers. A single movement of the toggle handle then serves to clamp all four blanks in place.

Another improvement, which will be seen from an examination of the engraving, is the provision of an adjustment for varying the height of the tool centers for cutting taper flutes. This obviates the necessity for blocking up the tail stock on operations of this kind. The tail centers are mounted in a wedge-shaped block which is adjustable on the inclined base provided for it, as shown, thus raising or lowering the tail center points. This gives a vertical adjustment of one inch.

The special advantages of this multiple spindle indexing device may be summed up as follows: First, it provides for great rapidity of action, owing to the use of the support for holding and locating the work before clamping, and the provision of a single movement of the lever for locking four pieces of work in place; second, and perhaps most important, the work when pressed back by the cutter into the driving dogs, is followed up and held fast by extra heavy springs, without the loosening which would result with screw tightened or other positively operated centers; third, taper work is provided for without blocking up. The size shown has a capacity for taps or reamers from ½ to 3 inch.

* * *

The annual reunion of the sales organization of Hill-Clarke & Co., Chicago, Ill., at which were present a large number of the manufacturers whom they represent, was held in the banquet hall of De Jonge's restaurant in Chicago on January 11, and the following evening they attended the theater as guests of the firm.

* * *

"Signs make business. . . . Apart from all business interest a sign on a factory is an ethical courtesy to the traveling public.—*Industrial Department Circular, Erie Railroad.*

NEW MACHINERY AND TOOLS NOTES

Double-end Angle Wrenches in Sets: Frank Mossberg Co., Attleboro, Mass. This firm provides its double-end angle wrenches in sets put up in a neat compartment canvas case, to be used for machine equipment, automobile kits, and standard engineers' and machinists' sets. The wrenches are carefully proportioned and made of a high grade of material. The five wrenches, being double ended, fit ten sizes of bolts and nuts.

Ball Bearing Hanger: Hess-Bright Mfg. Co., Philadelphia, Pa. This firm has devised a special form of hanger particularly adapted to the application of ball bearings to line shaftings. The hanger frame is of box section, and the bearing is provided with adjustments both vertically and horizontally. The design is such as to make the hanger simple in construction and easy to erect and adjust. The line comprises five sizes, practically covering the field for work of this character.

Independent Pump Hydraulic Jack: Duff Mfg. Co., Pittsburg, Pa. This jack, which the makers call the "Duff-Bethlehem," is of the type in which the pump is independent of the ram cylinder, being connected therewith by an 8-foot length of flexible copper tube. This construction permits the use of the jack in confined places and at any convenient angle. It is possible to use one pump for operating several jacks. It may also be employed for general shop work as a small hydraulic press. This apparatus is made in various capacities from 100 to 500 tons, with strokes ranging from 6 to 12 inches.

"Vulcan" Auto Tool: J. H. Williams & Co., Brooklyn, N. Y. This tool is a solid one-piece forging, which combines in itself a remarkable number of functions. It may be used as a hammer, tire lug wrench, cotter pin puller, gas tank wrench, wire insulator scraper, air tank wrench, spark plug wrench, alligator wrench, cotter pin spreader or screw-driver. As a screw-driver it should be particularly effective for confined places, as three blades are provided, set in three different positions. The category of its useful qualities would not be complete without mentioning also the provision of a bottle opener.

"Arpeco" Pipe and Nut Wrenches: Rogers, Printz & Co., Warren, Pa. These wrenches are of unusually simple construction, being formed only of two drop forgings, a drawn steel sleeve of seamless tubing, and a small screw, which serves to hold the parts together. The adjustment consists of the simple sliding of the parts on each other by the fingers of the hand which operates the wrench. A wedge action locks the jaws as soon as the operating pressure is applied. A special thin model is furnished of only ¼-inch thickness for the purpose of getting in small spaces.

Motor-driven Combined Vertical Milling and Slotting Machine: R. M. Clough, Tolland, Conn. This well-known machine is primarily a vertical miller, provided with a simple slotting attachment operated by a worm and worm-gear connection with the milling spindle. It is especially adapted for diemaking and similar work. It has recently been provided with a single motor drive; the connection between the machine and motor is made by a Morse silent chain. A 1½-horsepower, 120-volt Ridgway motor is used for the No. 2 size of machine.

Hydraulic Cold Tire-setting Machine: West Tire Setter Co., Rochester, N. Y. The well-known tire-setting machine made by this firm has recently been adapted to automobile work. When this machine is to be used, the tire is forged large enough so as to be strained beyond the elastic limit when pressing it on the wheel. The forcible compression has been found to densify and improve the metal. A recent machine was provided with 18 hydraulic rams, capable of exerting a pressure of 100 tons each, with a supply pressure of 2,000 pounds per square inch. For an ordinary automobile rim for a 4-inch tire, not more than 15 tons pressure for each ram would be required.

Combined Hand and Power Pipe Machine: Crane Co., Bridgeport, Conn. This machine has a capacity for pipe from ⅛ inch to 2 inches diameter, inclusive, and may be furnished with bolt threading dies as well in sizes ranging from ¼ to ½ inch. The main frame, consisting of the base and bed, is cast in one piece. Compactness for the electric drive is secured by mounting the motor under the rear overhang of the headstock, so that it requires no additional floor space. The action of the motor is by a belt or chain drive. Three speed changes are effected by a geared mechanism, controlled by a single lever. A rotary oil pump is provided for giving continuous lubrication to the dies.

Horizontal Riveting Machine: H. P. Townsend Mfg. Co., Hartford, Conn. The Townsend riveting machine (which was described in a note in the department of New Machinery and Tools in the February, 1909, number of Machinery) is now furnished in horizontal form as well as in the vertical design then described. It is intended for long or bulky work which it is inconvenient to handie in a vertical position. The action of the machine causes a series of disks to strike the end of the riveting hammer, giving a great number of blows per minute, the variation in blows being obtained by variation in speed. The machine will handle rivets from 1/64 up to 5/64 inch in diameter.

Multiple Spindle Milling Machine: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. This machine was built for special work, but involves a number of new features which might, perhaps, be applied to advantage in a great many general shop operations. The machine is of the planer type, with a horizontal spindle, having a driving head on one column and an outboard support on the other. The cross-rail carries two heads with vertical spindles. These heads are, however, adjustable, so that the spindles may be set at any angle out of the vertical desired, permitting the cutting of angular surfaces with ordinary end and face mills. The machine will mill work up to 16 feet long and 30 inches wide.

Combined Bench Center and Centering Machine: Artisan School, Syracuse, N. Y. This machine as indicated by its name serves the double purpose of indicating the truth of work mounted on centers and drilling center holes in rough stock with the standard form of combination center drill. The machine is provided with a graduated indicating pointer for showing the amount by which the work runs out of true. An adjustable V-block is provided for supporting work which otherwise would require a "third hand." The rod for knocking out the center drill or center (as may be required) is permanently mounted in the machine. The design of the framework and the general construction of the tool is unique, but of convenient and rational form.

Combination Bench and Vise Stand: New Britain Machine Co., New Britain, Conn. This device consists of a 5-inch vise, mounted on a solid iron tripod, either alone or in combination with a tray or bench top. The whole arrangement is compact and occupies a minimum of floor space. It is sold as a unit and is ready for service as soon as it is attached to the floor, on which it rests firmly no matter how uneven it may be. Any make of vise preferred by the customer will be furnished. When one of the swivel base type is used, the binder for locking it operates in a pocket in the front of the tripod rod. When a pipe vise is used, the shelves form a convenient place for dies, cutters or tongues. The size of the table is 20 by 40 inches. The weight complete is 375 pounds.

Tapping Attachment for Sensitive Drill: Taylor & Fenn Co., Hartford, Conn. We have previously described a number of designs of this make of drill press (see, for instance, the department of New Machinery and Tools in the May, 1909, number of Machinery). In this machine the speed changes for the spindle are obtained by a geared change mechanism in the base of the adjustable spindle column. The improved tapping attachment consists of a reversing mechanism, located at the same point and operated by a small projecting lever. The reverse of the spindle is effected by a clutch in combination with a set of bevel gears. The vertical movement of the spindle and its reverse can be controlled by the same hand, though a positive connection between the two movements will be furnished if desired.

Electric Tachometer: Industrial Instrument Co., Foxboro, Mass. This device is essentially an electrical generator, positively connected (by silent chain or otherwise) with the part whose speed is to be measured, and electrically connected with a special volt meter calibrated directly in revolutions per minute. The generator is of the alternating type, so that the uncertain action of brushes and other sliding contacts is avoided. Irregularities in the voltage and consequent vibration of the meter needle are avoided by driving the generator through a fly-wheel, whose connection with the motive power is through a coil spring, which absorbs momentary speed changes. As many indicating dials as may be desired can be attached to a single generator, so that information as to speed may be given in a number of places simultaneously.

Inserted Lathe Tool-holders: G. R. Lang Co., Meadville, Pa. These tools are made in a variety of designs, one of which is particularly interesting in obviating the use of the regulation spherical ring and tilting shoe. The tool is clamped solidly down onto a block on the cross-slide, no adjustment for height of tool being furnished or required, owing to the fact that the point of the tool is ground on the end and not at the top, thus keeping the height constant at the right position. Tools of this design are used for turning, side facing, cutting off, etc. A special cutting-off tool-holder (another new product) permits the use of a blade having flat top and bottom, the proper gripping force being provided without dove-tailing these surfaces as usual. Side clearance is provided so that the blades cut as well as a properly forged tool of the old style.

Hand-feed and Automatic Thread Rolling Machines: Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. This firm has redesigned its line of reciprocating thread rolling machines, and has introduced a number of improvements. An offset crank is used in place of the former quick return movement for giving a slow, powerful threading stroke. A new device is applied to prevent the possibility, in the automatic feed machines, of getting a blank into the feeding guides in a wrong position, and thus clogging the feed. Extra long dies are used, and provision is made for an extra length of thread as well. The six sizes have a maximum capacity for work from 1/4 to 1 inch in diameter, and for a depth of die ranging from 1 to 3 inches. They are built in horizontal form with automatic feed for small and medium work, and hand feed for the heaviest; and in an inclined form for automatically feeding headless blanks. All the mechanism of the machine is thoroughly guarded.

Micro-Adjustable Boring Head: Porter-Cable Machine Co., Syracuse, N. Y. This tool is intended for use in connection with the maker's sensitive high-speed universal milling attachment, but may be applied to milling machines and drill presses in general. It consists of a shank mounted in the spindle of the machine, carrying a head with cross-slide ways formed in it, on which the tool-holder is adjusted. This adjustment is effected by a micrometer screw with graduations reading to thousandths of an inch. The tool head is provided with a split chuck for holding the cylindrical shanks of the boring tools, and has suitable clamping arrangements for binding it firmly to the tool when the adjustment has been made. The tool itself has a 1/2-inch shank, and the draw-in chuck furnished is fitted for boring tools of 1/4-inch shank. The cross adjustment is 3/8 inch, making it possible to enlarge a hole 3/4 inch without change of tool. This device will be found very useful in the accurate boring of small holes in jigs, fixtures, dies, etc.

Telescoping Inside Gage: L. S. Starrett Co., Catalogue 18D, Athol, Mass. This gage is intended for use in measuring the exact size of holes or slots by the use of an outside micrometer caliper; the tool is, in fact, a transfer gage, very solid and accurate in construction. In general form it resembles a T-head wrench in which one of the arms of the T telescopes into the other, against spring pressure. After pressing together, it is locked by a thumb screw at the outer end of the shank and inserted in the hole. Releasing the thumb-screw allows the measuring arm to spring open to the diameter of the hole being measured. Locking the knurled thumb-screw again clamps the arms in this position, after which the tool is removed and the diameter measured. The end of each of the heads is hardened and ground to the radius of the smallest hole the tool enters. The instrument possesses advantages over the inside caliper in the matter of stiffness and accuracy. The gages are made in five sizes, having a range from 1/2 to 6 inches.

Fan Dynamometer for Testing Gasoline and other Motors: Joseph Tracy, 116 West 39th St., New York City. We have illustrated various arrangements of fans for absorbing the power when testing engines. These appliances have all been of the home-made order. The above manufacturer has now placed on the market a well-designed and compact apparatus for this purpose which offers several improvements over the home-made construction, the most noticeable of which is the provision of a tachometer directly connected with the spindle so as to give speed readings at all times. The resistance blades on the arms of the fan are radially adjustable to absorb more or less power. For any given position of these blades the tachometer dial may be calibrated to read directly for the power appropriate to a given speed. A series of dials is provided for different positions of the blades, so that the machine will read the power absorption directly over a range running from 1 horsepower at 180 revolutions to 70 horsepower at 980 revolutions.

End Mills for Precision Work: Porter-Cable Machine Co., Syracuse, N. Y. These end mills are built for high-speed operation on fine work, and range in size from 1/16 inch to 5/8 inch in diameter. The mills from 1/16 to 5/32 inch are provided with but a single tooth, which is cut to the center so that the tool may be fed directly into the work like a drill. The sizes from 3/16 to 1/4 inch have two teeth, also cut to the center. All of these mills have straight teeth. For the sizes from 1/4 to 5/8 inch diameter, four or six teeth are used, cut spirally; the larger sizes are made of high-speed steel. The teeth of the mills are given a peculiar form which greatly increases their strength, effecting a large saving in the matter of drill breakages. The unusually small number of teeth used has been found by the makers of exceptionally great advantage. Each tooth has a much stronger backing and is much less liable to break. Their metal-removing capacity is as great as in the older multiple tooth styles, since it has been found that in most cases but one tooth at a time would work anyway. While these tools were designed particularly for the maker's high-speed milling attachment, they are applicable as well to any high-speed milling machine built for accurate work.

Automatic Temperature Regulator for Gas Furnaces: American Gas Furnace Co., 24 John St., New York City. This device is designed to work in connection with a thermo-electric pyrometer, and it is so constructed that the exceedingly delicate movements of the needle of that instrument control a mechanism for opening and closing the gas and air valves without interfering to the slightest degree with the sensitiveness of the operation of the indicating mechanism. It will be admitted that this is something of an achievement in mechanical construction. The power for the valve movements is furnished by a small fan motor connected by a 1/4-inch pipe

with the regular air supply of the furnace, so that no special motive power connections are required. The mechanical control of this motor by the needle is effected by a system of interferences, which that needle offers to members driven by the motor. This interference is effected without restraining to the slightest degree the movements of the needle itself. The instrument is designed to hold the temperature control steady within five or ten degrees of a given point of temperature. It may be instantaneously adjusted to any point on the temperature scale, and it is so constructed and enclosed as to be durable and fool-proof.

Engine for Fan and Generating Sets: B. F. Sturtevant Co., Hyde Park, Mass. This firm has for many years built a line of engines for driving either by belt or direct connection the fans and generators which they manufacture. They recently placed on the market a new model of vertical single engine for this work, which incorporates all the improvements which their past experience in this line has suggested. It is of the high-speed, closed type, having openings fitted with dust-proof covers which can be easily removed. A distance piece is provided between the cylinder and the frame which permits access to the stuffing box, and provides, as well, a watershed for keeping the oil from the frame out of the cylinder, and for keeping the water of condensation from the cylinder out of the frame. An oil reservoir is mounted on the frame, from which the oil flows to all the bearings, through piping equipped with sight feed regulators. A reservoir cast in the base receives the oil, where it is filtered through a fine screen and then pumped back to the reservoir. The pump may be dispensed with by keeping the reservoir at the top full, drawing off the excess from the bottom. The Rites inertia governor is used, and provides for a maximum variation of speed between no load and full load of not more than 1½ per cent. For direct connection with a pump, fan or similar apparatus, the base is extended so as to make the whole installation a complete unit. These engines are carefully tested before leaving the works. Particular stress is laid on compactness, economy, dependability and smooth running features, making the engines particularly adapted to isolated electric plants.

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WAGE RAISE RECOMMENDED BY N. M. T. A

Commissioner Robert Wuest, of Cleveland, Ohio, in his monthly letter for January to the members of the National Metal Trades Association, recommends that the members raise wages of their employes wherever possible to keep pace with the great increased cost of living. He says in part:

"To increase wages as the demand for labor increases is good business. That it is doubly good business when an era of great prosperity is at hand cannot be denied. Let us see what would follow this increase of wages of our employes: First, it will keep them in their shops instead of driving them into other shops; second, it will keep them contented and ready to work with hearty good will; third, it will keep our products up to the standard of practice of the times because it will enable us to retain efficient workmen.

"Speaking generally, it is fair to say that the wise policy of manufacturers is to pay their employes the best wages that they can afford to pay. Voicing the sentiment which pervades the councils of the National Metal Trades Association, we wish to impress upon our members the importance of remembering this. The more it is remembered and practiced, the longer we will be immune from strikes and their consequences.

"The papers of the country at this time are full of talk about the increased cost of living. The reasons assigned for this increase are many and varied. . . . But be the reasons what they may, the fact is undeniable that a dollar does not go nearly so far to-day as four or five years ago. It would seem to be good business for all our members to take to heart the foregoing on the wage question. Good wages, the proper education of employes—especially apprentices—the adoption of practical and equitable profit-sharing systems are important factors in the solution of the labor problem."

* * *

TENTH INTERNATIONAL AUTOMOBILE SHOW

The Tenth International Automobile Show was held in the Grand Central Palace, New York City, December 31, 1909, to January 7, 1910, under the management of the American Motor Car Manufacturers' Association. There were over eighty exhibitors of vehicles, and a great number of exhibitors of accessories, the exhibition being distributed over the main floor and the two balconies. The American Motor Car Manufacturers' Association numbers forty-three members, and it is of some interest to note the principal features of the cars brought out by the members of the association. In all, there are 183 different pleasure cars and 86 commercial vehicles made by the members of the association and specified as 1910 models. Of the pleasure cars, only 6 are one-cylinder cars, 14 are two-cylinder cars, one is a two-cycle three-cylinder car, 19 are six-cylinder cars, and the remaining 143 are four-cylinder cars. Of the commercial vehicles the smaller sizes in general are two-cylinder cars, these numbering 50, while 36 are four-cylinder cars. Of the pleasure vehicles only 12 are specified as air cooled, one is either air- or water-cooled, while 170 are water-cooled. Of the commercial vehicles 4 are air-cooled, 7 are either air- or water-cooled and 75 are water-cooled. As regards the approximate power of the cars, 12 of the pleasure cars are of less than 15 H. P.; 30 are between 20 and 25 H. P.; 38 are of 30 H. P. or thereabouts; 24 of 35 H. P.; 20, 40 H. P.; 14, 45 H. P.; 25, 50 H. P.; and 18, 60 H. P. or more. Of the commercial vehicles, 10 are of 20 H. P. or less; 9 of about 25 H. P.; 29 of about 30 H. P.; 4 between 30 and 50 H. P.; 33, 50 H. P.; and one 60 H. P. As regards price, 27 of the pleasure vehicles are priced at less than $1,000; 29 between $1,500 and $2,000; 45 between $2,000 and $2,500; 29 between $2,500 and $3,000; 24 between $3,000 and $4,000; and 29 at over $4,000. Of the commercial vehicles 11 are specified at a price below $1,000; 10 between $2,000 and $3,000; 9 between $3,000 and $4,000; 17 between $4,000 and $5,000, and 10 above $5,000. The price of a number of commercial vehicles is furnished only on application, so that the figures above do not include the whole list of all makes.

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TENTH A. L. A. M. AUTOMOBILE SHOW

The Tenth National Automobile Show took place under the auspices of the Association of Licensed Automobile Manufacturers at the Madison Square Garden, January 8 to 15. There was a total of 56 exhibitors of complete cars, 21 motor-cycle exhibitors, and 246 exhibitors of accessories and parts. The tremendous growth of the automobile industry in the last few years was plainly in evidence to anyone who has had an opportunity to see the National Automobile Show from year to year. On the main floor and on the elevated platform were placed only gasoline pleasure cars, while electric pleasure vehicles were exhibited in an exhibition floor of their own. The basement was occupied by commercial vehicles and motorcycles, while the concert hall and balconies accommodated the exhibitors of accessories. The Madison Square Garden was exquisitely decorated for the event, it being stated that more than $35,000 was spent on decorations. In all, there were 91 gasoline pleasure cars, 2 steam pleasure cars, 22 gasoline commercial cars, and 23 electric pleasure cars exhibited. Of the gasoline pleasure cars 65 were four-cylinder cars and 26 six-cylinder cars. Of the gasoline commercial cars one was a one-cylinder car, 4 were two cylinder cars, and 17, four-cylinder cars. All the pleasure cars, with the exception of five, and all the commercial cars, with the exception of six, were water-cooled. As regards the power of the cars 2 of the gasoline pleasure cars were of less than 20 H. P., 29 were between 20 and 30 H. P., 20 were between 30 and 40 H. P., and 20 were between 40 and 50 H. P., while 18 were 50 H. P. and over. The power of two of the gasoline pleasure cars was not specified. Of the commercial cars 5 were under 20 H. P., 10 were between 20 and 40, and 6 were 40 H. P. and over. As regards price, 3 of the exhibited cars were priced at less than $1,000, 10 between $1,000 and $1,500, 12 between $1,500 and $2,000, 7 between $2,000 and $2,500, 10 between $2,500 and $3,000, 27 between $3,000 and $4,000, 31 between $4,000 and $5,000, and 30, $5,000 and over.

* * *

A. L. Pfitzner recently made an exhibition flight at Hammandsport, N. Y., with a monoplane equipped with a new balancing device which, it is claimed, does not infringe upon the Wright patents on the warped plane principle. The Pfitzner device consists of two sliding panels at the outer ends of each wing. These panels are mounted on tracks under the wings, and are controlled by cords leading to the operator's seat. Changing the position of the panels accomplishes the same results in the balancing of the monoplane as warping the wings in the Wright models.

* * *

Don't think you are a machinist until you can take a set of drawings and produce from them what the draftsman wants made.

A METHOD FOR LOCATING THE DECIMAL POINT IN SLIDE RULE CALCULATIONS

CHAS. G. RICHARDSON*

The location of the decimal point in the results of multiplication and division has proven a vexatious problem to most users of the slide rule. The formulas heretofore given have proved cumbersome and confusing; inapplicable, practically, to examples of any length. It is believed, therefore, that the following easily remembered method will commend itself to all interested. Bearing in mind that when the words "left-hand figures" are used, *the number of figures to the left of the decimal point* (or in the integral portion of the number) is meant, there are two short rules which must be thoroughly memorized.

RULE No. 1. *Multiplication.* The left-hand figures in the product equal the sum of the left-hand figures in the factors, *except* that one left-hand figure must be subtracted for each time the slide projects to the right.

RULE No. 2. *Division.* The left-hand figures in the quotient equals the left-hand figures in the dividend minus the left-hand figures in the divisor, *except* that one left-hand figure must be added to those in the dividend for each time the slide projects to the right.

These two rules embody the whole method, and once having been learned, there only remains their application. Note that absolutely no reference is made to slide projections to the left.

The "left-hand figures" would be

3	in	843.210
2	in	41.189
1	in	6.922
0	in	0.632
—1	in	0.028
—2	in	0.003 etc.

The use of the two rules will now be illustrated by examples chosen at random, leading from simple problems to those more complex. The calculations are given in detail, but after a little practice the decimal point can be determined mentally with great rapidity.

(Note: It is understood that the lower scales on the slide rule are used.)

Example: $8 \times 5 = 40$.

The slide does not project to the right, therefore add the left-hand figures of the factors, giving two in the product.

Example: $8 \times 5 \times 12 = 480$.

The slide projects once to the right, therefore add left-hand figures of factors and subtract 1, giving 3 units in product.

Example: $8 \times 5 \times 12 \times 0.16 \times 0.08 = 6.14$.

The slide projects twice to the right, therefore $(1 + 1 + 2 + 0 - 1) - 2 = 1$ left-hand figure in the product.

Example: $128.1 \times 132.16 \times 14 \times 11 \times 0.008 \times 0.61 = 12720$.

The slide projects three times to the right, therefore $(3 + 3 + 2 + 2 - 2 + 0) - 3 = 5$ left-hand figures in the product.

Example: $\dfrac{140}{20} = 7$.

The slide does not project to the right, therefore subtract the divisor's left-hand figures from the dividend's, or $3 - 2 = 1$ figure in the quotient.

Example: $\dfrac{360}{24} = 15$.

The slide projects once to the right, therefore add 1 to the dividend's left-hand figures and then subtract the divisor's, or $(3 + 1) - 2 = 2$ left-hand figures in the quotient.

Example: $\dfrac{3600}{24 \times 12} = 12.5$.

The slide projects twice to the right; therefore $(4 + 2) - (2 + 2) = 2$ left-hand figures in the quotient.

Example: $\dfrac{3600}{24 \times 0.12 \times 0.004 \times 18} = 17360$.

The slide projects three times to the right, or there are $(4 + 3) - (2 + 0 - 2 + 2) = 5$ left-hand figures in the quotient.

In formulas involving a combination of multiplication and division, the value of the method especially asserts itself.

Example: $\dfrac{12 \times 8}{16 \times 2} = 3$.

Alternately dividing and multiplying to save unnecessary settings, gives one projection to the right in *division*, but none in multiplication. Therefore, adding 1 to the dividend's left-hand figures and subtracting the divisor's, we have $(2 + 1 + 1) - (2 + 1) = 1$ left-hand figure in the result.

Example: $\dfrac{16 \times 14 \times 24}{30 \times 72 \times 0.8} = 3.11$.

Here we have one projection to the right in *multiplication*, but none in division and consequently $(2 + 2 + 2 - 1) - (2 + 2 + 0) = 1$ left-hand figure in the result.

As we proceed to longer examples it becomes rather difficult to separate *mentally* the number of projections to the right in multiplication from those in division. Short vertical lines may be used to keep this score, as it might be called, these marks being placed either above or below the division line according to whether the operation is respectively one of multiplication or division. Inasmuch, however, as a projection to the right in multiplication *subtracts* 1 and a projection to the right in division *adds* 1 to the left-hand figures in the dividend, it is unnecessary to score every projection to the right, as such a projection in division often may be immediately balanced by moving the runner to the next number in the dividend. In other words, it is only the *unbalanced* projections to the right which it is necessary to record.

To illustrate:

$$\text{Score}\left\{\begin{array}{l}\text{I}\\ \text{II}\end{array}\right. \quad \frac{114 \times 232 \times 1.98 \times 0.0006 \times 188}{196 \times 0.064 \times 72 \times 0.12 \times 14 \times 12.6} = 0.309.$$

Taking the solution step by step

114 ÷ 196	......slide is to left		
Multiply by 232	......slide is to left		
Divide by 0.064	......slide is to left		
Multiply by 1.98	......slide is to right	(mark above line)	
Divide by 72	......slide is to left		
Multiply by 0.0006	......slide is to left		
Divide by 0.12	......slide is to right	balance	
Multiply by 188	......slide is to right		
Divide by 14	......slide is to right	(mark below line)	
Divide by 12.6	......slide is to right	(mark below line)	

Now the excess of the lower group of "marks" over the upper is 1, therefore the slide has gone to the right once more in division than in multiplication, and 1 is to be added to the dividend's left-hand figures before subtracting the divisor's, or $(3 + 3 + 1 - 3 + 3 + 1) - (3 - 1 + 2 + 0 + 2 + 2) = 0$.

It makes no difference as to the order in which the problem is solved; the *excess* of one group of projections over the other will be the same. Gratifying "results" will certainly follow a little careful study and practical application of the simple principles enumerated.

* Address: Builders' Iron Foundry, Providence, R. I.

* * *

A new 14-inch gun for battleships is being constructed at the Washington Navy Yard. This gun will have an extreme range of 25 miles, although the range at which it will be fired in regular action will be about 5 miles. The projectile from this new gun leaves the muzzle at the velocity of 2,000 feet per second, and when fired with a full charge of 365 pounds of powder it will penetrate 22.7 inches of Krupp steel armor plate, when leaving the muzzle. The projectile weighs 1,400 pounds and the total length of the gun is 53½ feet.

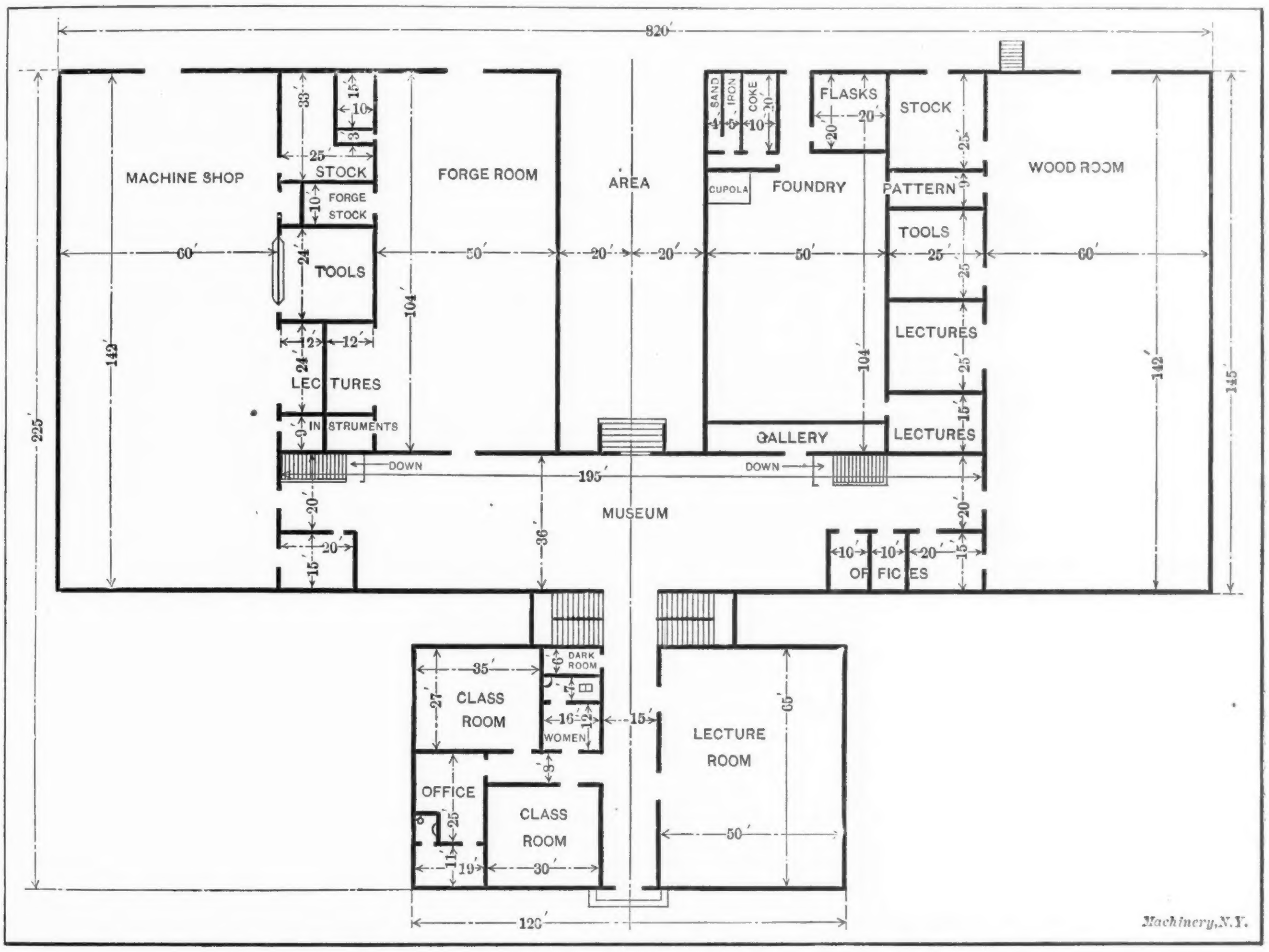
* * *

A prize of 50,000 francs has been offered by the Turin (Italy) Chamber of Commerce, in connection with the Turin Exposition of 1911, for that invention or discovery, made before 1908, that has proved in practice of the greatest advantage in promoting national economy. Applications are to be made, in Italian or French, before April 1, 1911, to "Commissione per il Concorso a Premis, Camera di Commercio, Torino, Italia."

NEW SHOPS AT PURDUE UNIVERSITY

The new buildings which are now under way for the Department of Practical Mechanics at Purdue University, Lafayette, Ind., are worthy of notice as representing a notable advance in the efficiency of practical instruction at that institution.

The organization of this branch of work at Purdue is somewhat different from that in most other technical schools. The department of Practical Mechanics stands by itself, independent of the School of Mechanical Engineering and bearing to the latter somewhat the same relation as do the departments of Mathematics or Applied Mechanics. The department is in charge of a staff of professors and instructors and covers the work done in elementary mechanical drawing, descriptive geometry and shop instruction.



Plan of New Shops for Department of Practical Mechanics Purdue University

In 1909 the State Legislature recognized the crowded condition of the present shops and drawing rooms and appropriated the sum of $170,000 for new buildings and equipment. Plans and specifications were prepared, contracts let and in May of that year work was begun on the new plant.

As may be seen from the outline plan, the buildings form a connected group containing a front or main building, a longitudinal corridor and transverse wings. The general construction is of the factory type with concrete foundations, brick walls and roofs lighted from above. The main building, 65 by 120 feet, three stories high, furnishes accommodations for class-room instruction and for drawing. On the ground floor are offices, class-rooms and a lecture room 50 by 65 feet. The second and third floors each contain two large drawing rooms and the necessary offices, blue-print rooms, etc.

The remaining buildings are one story in height. A long corridor joining the shops proper has in the basement the heating plant and space for lockers and wash-rooms, while its ground floor contains offices and cases for exhibits and models. The wood shop, 60 by 142 feet, and the foundry, 50 by 104 feet, each under a separate roof, form one wing with an intermediate space of 25 feet used for tools, stock and demonstration rooms. Each building is lighted from overhead as well as from the sides and is capable of indefinite extension in the rear. A basement under the wood shop accommodates stored lumber and contains the shafting and motors for driving the machinery on the main floor. A similar group on the south side contains the machine shop, the foundry and the connecting store rooms and demonstration rooms. The basement of the machine shop will be used for storage.

The buildings will be lighted throughout by electricity and heated by a combined radiation and blower system, insuring uniform temperature and thorough ventilation. The machinery in the shops will be driven by electric motors, both group and independent drives being employed. Alternating and direct currents will be available for the two classes of transmission used.

We are indebted to Prof. Charles H. Benjamin, dean of the Schools of Engineering and Director of the Engineering Laboratory for the foregoing information.

* * *

LUBRICATION AND LUBRICANTS

At the regular monthly meeting of the American Society of Mechanical Engineers, January 11, papers on the subject of lubrication and lubricants were read and discussed. The authors of the papers were Dr. Charles F. Mabery, professor of chemistry at the Case School of Applied Science, of Cleveland, Ohio; Prof. F. H. Sibley, of the University of Alabama, and Dr. P. H. Conradson, of the Galena Signal Oil Co.

Dr. Mabery's paper dealt especially with laboratory tests of lubricants containing deflocculated graphite, but contained also considerable matter of direct practical application. The various fields of usefulness of different lubricants were referred to. Greases compounded with graphite, for example, are of particular advantage on low-speed bearings, under heavy load, while natural graphite serves an excellent purpose in cast iron bearings, where it appears to smooth the surface of the porous metal. On close grained surfaces highly finished, however, care must be exercised so that it does not collect and scratch and abrade the journals and bearing.

Some of the tests on the deflocculated graphite gave very interesting results. It was found that a very small amount of graphite suspended in water serves its purpose as an efficient lubricant. For example, an amount of only 0.35 per cent of graphite in water will sustain a pressure of 70 pounds per square inch in the bearing, and a larger amount than that is superfluous. Experiments were also carried out with graphite deflocculated in kerosene and various lubricating oils. It was found that one cubic inch of graphite in three gallons of oil is sufficient to give excellent results and materially reduce friction. Experiments were also undertaken with a view to determine the rise in temperature with the various lubricants, and the most remarkable result in this direction was that graphite suspended in water is an excellent lubrication means for keeping the temperature of the bearings constant. The increase in temperature when testing with this lubricant did not exceed 5 degrees F.

Prof. Sibley's paper described experiments undertaken to determine the relation between viscosity and the wearing and lubricating qualities of oils, and the effect of the constituents of various oils on the lubricating qualities. Twenty-two oils were tested, the method of procedure being to find the chemical composition and viscosity of each oil, and then use it as a lubricant in a journal bearing. The viscosity of an oil is measured by its resistance to flow, a strong resistance to flow indicating a high viscosity. The experiments showed that the viscosity of an oil affects its lubricating quality in the following way: If the oil is adapted to the load put upon it, then the lower the viscosity the better the oil as a lubricant. The oil, however, must conform to the character of the load, a light oil being unsuitable for heavy loads.

While the two previous papers dealt particularly with laboratory tests of oils, Dr. Conradson's paper dealt more directly with practical conditions, and oils suitable for steam turbine plant lubrication, railroad journal lubrication, etc., were discussed by him, as well as several other practical considerations affecting lubricants.

In the discussion following the reading of the papers, Mr. Henry Souther made some interesting remarks relating to the lubrication of automobile cylinders. He had found by practical experiments that a high flash-point oil is not desirable, because of the gum and residue that always results from oils of this kind. These oils give good lubrication while running, but make it difficult to start the engine after it has been standing. The most desirable lubricant for an automobile cylinder is an oil which will take care of the main shaft bearing and the main pin bearings of the piston, and then passing up the piston into the explosion chamber, will disappear as much as possible, so as not to leave any considerable amount of residue oil. Such oils have viscosity of 40 to 50 seconds at 210 degrees F., as measured by the Saybolt viscosimeter, and a specific gravity of from 28 to 31 Beaume.

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PERSONALS

The present address of P. L. Joselevitsch, formerly of 733 E. 16th St., Minneapolis, Minn., is desired by the editor.

W. B. Engler, formerly assistant chief engineer of the Reliance Motor Truck Co., Owosso, Mich., has now been made superintendent of that company.

John J. Grant has been made consulting engineer of all the constituent plants of the Everitt-Metzger-Flanders Co., automobile builders, Detroit, Mich.

Oscar Stegeman has associated himself with Messrs. Landau & Golden, consulting engineers, New York, as a western engineer. He will be located in Milwaukee, Wis.

George H. Hall was recently transferred from the Boston office of the Sprague Electric Co. to its motor and generator department in the company's general office, New York City.

John J. Murphy, blacksmith foreman for the Wabash R. R. at Moberly, Mo., has been appointed to a similar position at Decatur, Ill., succeeding Christopher Jackson, resigned.

Joseph J. Reid has taken charge of the eastern sales department of the Harris Automatic Press Co., with the title of eastern manager. He succeeds E. E. Barney, resigned.

Christopher Jackson, blacksmith foreman at the Wabash Car Shops, Decatur, Ill., left January 1 for Dayton, Ohio, to become superintendent of forges for the Barney & Smith Car Co.

H. C. Fay, of the engineering department of the Remington Arms Co., Ilion, N. Y., has been appointed foreman of the chucking and punch press department to succeed W. H. Dotzauer, resigned.

W. J. Greer, better known as "Genial Jack" Greer, is back again among his own in Pittsburg representing the interests of the Van Dorn Electric and Mfg. Co., maker of electric drills and reamers.

C. E. Chambers has been appointed superintendent of motive power of the Central Railroad of New Jersey, with office at Jersey City, N. J. Mr. Chambers succeeds Mr. William McIntosh, who was superintendent of motive power for many years.

Cyrus F. Raymond, organizing engineer and industrial expert recently employed by the Warner & Swasey Co., Cleveland, Ohio, and later by the Coe Mfg. Co., Painesville, Ohio, has been made superintendent of the Davis-Bournonville Co., New York.

George S. Brown has resigned the position of foreman of the screw department of J. Stevens Arms and Tool Co., to take the management of the Mellor Mfg. Co., Springfield, Mass., a recently established plant for making screw machine products.

Paul Stoner has joined the selling force of the American Emery Wheel Works, Providence, R. I. Mr. Stoner was connected with the Landis Tool Co. for several years, and later with the Allis-Chalmers Co. and the Cleveland Automatic Machine Co.

W. R. Lathrop, who for several years has been connected with the Niles-Bement-Pond Co.'s New York and Birmingham office, has severed his connection and has associated himself with M. E. Dewstoe of Birmingham, Ala., forming the Dewstoe-Lathrop Machinery Co.

George W. Johnson, who lately resigned the superintendency of the Chapman Valve Mfg. Co., Springfield, Mass, has established the Springfield Equipment Co. to do a general mill and factory supply business. He will locally represent the Heller Bros. Steel Co., Newark, N. J.

P. J. Illing, manager of Ludw. Loewe & Co.'s commercial department, sailed for New York the latter part of January on the *Kaiser Wilhelm der Grosse*. He intends to visit the principal machinery manufacturing plants with the object of renewing and opening business connections.

W. H. Dotzauer, foreman of the chucking and punch press department of the Remington Arms Co., Ilion, N. Y., and who has also held the position of foreman in several other departments for the last fifteen years, has resigned to take the position of superintendent of the automobile hub department of the Weston-Mott Co., Flint, Mich.

H. E. Frentzel, for many years superintendent of the shops of Pawling & Harnischfeger, Milwaukee, Wis., retired January 1. He was succeeded by Otto A. Ruemelin, for several years past assistant superintendent. Mr. Frentzel was presented with a handsome silver service by his associates in the shop and office as a mark of their friendship and esteem.

W. R. Wilson, formerly general superintendent of the Columbus Brass Co. and the Columbus Iron Fittings Co., Columbus, Ohio, is now general manager and receiver for the Standish Machine & Supply Co., of that city, manufacturer of the Robinson right angle drive. Under Mr. Wilson's efficient management it is expected that the company will soon be in first-class shape.

J. D. Cox has been elected president of the Cleveland Twist Drill Co., Cleveland, Ohio, to succeed Mr. F. F. Prentiss, who resigned on account of ill health. Mr. Cox is the founder of the business, and has always been the practical man of the concern. He has probably had more experience and been closer in touch with the manufacture of twist drills than any other man now living.

F. A. Hall, who for the past twelve years was manager of the chain block and hoist department of the Yale & Towne Mfg. Co., New York and Hartford, has resigned to take the position of vice-president and treasurer of the Cameron Engineering Co., Brooklyn, New York. Mr. Hall is succeeded by R. T. Hodgkins, who for several years was his chief assistant and who is thoroughly qualified by experience and ability to fill the position.

Henry J. Smith has been promoted from the position of assistant foreman to the foremanship of the Water Shops of the United States Armory at Springfield, Mass. Mr. Smith was promoted from machinist to assistant foreman in 1898. The position of assistant foreman in the Water Shops is practically the same as that of foreman in civilian shops, the term being applied to the heads of departments such as milling, drilling, drop forging, etc.

J. W. Coyle, who was connected with the W. N. Best American Calorific Co. until its retirement from business, is now with the Rockwell Furnace Co., New York, and is giving special attention to oil and gas furnaces for railroad work. Mr. Coyle is an experienced railroad man, having formerly been master blacksmith for the Lehigh Valley R. R. at Wilkesbarre, and later was in charge of the drop hammer and machine department at the forge shops of the Philadelphia & Reading Ry., Reading, Pa.

George Walworth Hayden has been appointed general plant manager of the works of the Pratt & Cady Co. at Hartford, Conn. Mr. Hayden was for nineteen years with the Crane Co. of Chicago working in all departments and rising to be general manager of all its factories, having been chief draftsman, foreman, superintendent and general manager of all the brass, malleable and cast iron departments. He was also in the employ of the United States Steel Corporation and of the McNab & Harlan Co. as works manager at Newark, N. J.

C. H. Ladd has retired from the position of foreman of the Water Shops of the United States Armory at Springfield, Mass., after serving in that capacity for seventeen years. Previous to going to the Water Shops Mr. Ladd was at the Smith & Wesson revolver factory for fourteen years holding the position of foreman and superintendent. He is a Civil War veteran. In civilian shops the position he filled would be called superintendent. He had about five hundred men under him in several departments, including tool-making, hand, drop and rolled forging, milling, drilling, rifling, etc.

At a meeting of the board of directors of the Pennsylvania R. R., January 12, F. E. Abercrombie, superintendent of the New York division, C. F. Dabney, superintendent of the Central division, and W. A. Bannard, superintendent of the Maryland division, were delegated to the general manager's office at Philadelphia to assist in exhaustive investigations of various transportation problems. These men, who are to be known as special agents on the staff of the general manager, are well fitted for their duties on account of long experience in the operating department, especially divisional work, of the railroad.

Charles Kirchhoff, who recently retired from the editorship of the *Iron Age*, was given a tribute of regard in a luncheon at the Engineers' Club, New York, January 16, just prior to sailing on a cruise to the West Indies. The luncheon was attended by about 120 manufacturers, professors, editors, chemists, etc., prominent in the business world and their professions. Letters of regret were read from Andrew Carnegie, Ambrose Swasey, John Hayes Hammond, H. G. Prout, Prof. Henry M. Howe and others. Mr. Kirchhoff was presented with a bronze statue by Picault entitled "La Source du Pactole," by his colleagues on the *Iron Age*, as an evidence of regard and admiration. Mr. George W. Cope, who made the presentation, said in part referring to the gift: "It is emblematical of your profession as well as of the cause in which you have so long employed your energies and your talents. The engineer holding in one hand the dividers and in the other a hammer, contemplates the Pactolian stream, and as he muses we can well believe that he exults in the thought that his labor is also productive of wealth. How much and how effectively your labors have contributed to the material benefit of those who have for years used the *Iron Age* as an important factor in the conduct of their business is beyond my power to estimate."

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OBITUARIES

Samuel E. Riendeau, assistant foreman of the screw department of the J. Stevens Arms and Tool Co., Chicopee Falls, Mass., died at his home December 21, aged thirty-eight years.

George S. Taylor, treasurer of the Belcher & Taylor Agricultural Tool Co., Chicopee Falls, Mass., since its incorporation in 1864, died of pneumonia at his home in Chicopee Falls, Mass., January 3, after an illness of four days, aged eighty-eight.

William Baxter, Jr., died at his home in Jersey City, January 12, after a brief illness with pneumonia, aged fifty-six years. He was born in Troy, N. Y., and was given an academic education. He acquired considerable valuable experience in designing steam and hydraulic machinery between 1860 and 1880 with his father, William Baxter, Sr., who was a well known builder of engines and machinery and an inventor of considerable reputation. William Baxter, Jr., inherited the inventiveness of his father and made several inventions of merit in electrical apparatus, elevators, etc. He entered the electrical engineering field in the early eighties and afterwards devoted himself largely to this work and elevator improvements. He was a pioneer motor inventor and manufacturer. He invented the first enclosed arc lamp about 1882. He put stationary motors on the market in 1886 and railway motors in 1890. He was the first to design and place on the market the single reduction type of railway motors now universally used on trolley cars. Previous to Mr. Baxter's improvement, motors were double reduction with intermediate shaft between the motors and car axle. This arrangement was used to obtain sufficient power to operate the car without making the motor too heavy. Since 1895 Mr. Baxter had acted as a consulting engineer and writer. He wrote extensively for various mechanical and electrical journals on nearly all the industrial applications of electricity, and on elevators of all kinds. His series, "Electrical Railway Machinery and Apparatus," recently published in the railway edition of MACHINERY, is a case in point.

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Don't grind a lot of clearance on one side and no clearance on the other side of a thread tool.

COMING EVENTS

April 13-14.—Annual convention of the National Metal Trades Association at the Hotel Astor, New York. Robert Wuest, commissioner, 605 New England Building, Cleveland, Ohio.

April 17-June 1 (April 4 to May 19, O. S.).—International exhibition of internal combustion motors under the auspices of the Imperial Russian Technical Society of St. Petersburg on the premises of the society Panteleimonskaia No. 2. The object of the exhibition is to acquaint the consumer as well as the general public at large with the development and present condition of internal combustion motors, and to show the comparative advantages of each of the existing systems. The exhibit will be divided into sections as follows: Motors for agricultural purposes, motors for artisan in small industries, and domestic use, motors for factories, motors for marine, railway, tram-car, automobile, aeronautical and similar purposes, motor details and accessories, literature on motors, drawings, diagrams, etc.

May 4-5.—Annual meeting of the Iron and Steel Institute at the Institution of Civil Engineers, London. G. C. Lloyd, secretary, 28 Victoria St., London.

May 31-June 3.—Spring meeting of the American Society of Mechanical Engineers, Atlantic City, N. J.

June 1-August 31.—American Exposition in Berlin, under illustrious auspices, to stimulate trade relations between Germany and America. This will be the first all-American exposition ever held in a foreign country and will be of interest to all Europe as well as America. It will be held during three of the best months of the year for an exposition, being at the full tide of the foreign travel, when people will be attracted in large numbers. Max Vieweger, American Manager, 50 Church St., New York.

June 6-10.—Convention and exhibition of the Foundry & Manufacturers' Supply Association, Detroit, Mich., C. E. Hoyt, secretary, Lewis Institute, Chicago, Ill. Cadillac Hotel, Detroit, headquarters of the association convention week.

June 7-9.—Convention of the American Foundrymen's Association and American Brass Founders' Association, Detroit, Mich. Headquarters, Hotel Ponchartrain. Richard Moldenke, secretary. American Foundrymen's Association, Watchung, N. J. W. M. Corse, secretary. American Brass Founders' Association.

June 13-16.—National Gas and Gasoline Engine Trades Association convention at Cincinnati, Ohio, Hotel Sinton, headquarters. Albert Stritmatter, secretary.

June 23-28.—International Congress of Mining, Metallurgy, Applied Mechanics and Practical Geology at Dusseldorf, Germany. For information apply to G. C. Lloyd, 28 Victoria St., London.

July 26-29.—Joint meeting of the American Society of Mechanical Engineers and the British Institute of Mechanical Engineers in Birmingham and London, England.

SOCIETIES AND COLLEGES

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS, organized in 1901, elected the following new officers at the last annual meeting at Lima, Ohio, November 19-20: president, O. F. Rabbe, Toledo, Ohio; vice-president, Grant Miller, Toledo, Ohio; secretary and treasurer, Prof. F. E. Sanborn, Columbus, Ohio; managers, Ira Cole, Lima, Ohio, C. F. Baker, Covington, Ky., E. M. Adams, Akron, Ohio.

SOCIETY OF ENGINEERS, 17 Victoria St., Westminster, S. W. England will award a status prize each year for the next four years ending 1913 for the best paper written by any person on the subject "How to Improve the Status of Engineers and Engineering with Special Reference to the Consulting Engineer." The prize will be books or instruments or both to the value of three guineas selected by the author of the winning essay. Essays should be written in the third person and should contain not fewer than 4,000, or more than 6,000, words.

STEVENS ENGINEERING SOCIETY, Hoboken, N. J. Program of lectures for the season 1909-10. The society is affiliated with the American Society of Mechanical Engineers. The speakers yet to appear are Samuel Whinery, February 8, subject, "Pavements for City Streets;" David S. Jacobus, February 15, subject, "Power Plant Economics;" Henry L. Gantt, February 21, subject, "The Engineer as a Manager;" John F. O'Rourke, March 1, subject, to be announced; Hermann F. Cuntz, March 8, subject, "Automobiles;" William J. Hammer, March 15, subject to be announced; Charles R. Richards, March 22, subject "Art and Industries of the Orient;" George V. Wendell, March 31, subject, "The Gyrostat and its Application;" Lewis A. Martin, April 5, subject, "The Theory of Gyrostatic Motion;" Frank B. Gilbreth, April 12, subject, "Methods and System in Relation to Handling Concrete Work;" John C. Ostrup, April 19, subject, "Notable Examples in Modern Construction;" David Watson Taylor, April 26, subject, "Development of the New Navy;" Charles F. Kroeh, May 3, subject, "Immortality;" John A. Brashear, May 10, subject, "The Contribution of Photography to our Knowledge of the Stellar Universe."

NEW BOOKS AND PAMPHLETS

GOOD ROADS. Bulletin No. 20. 53 pages, 6 x 9 inches. Published by the University of South Carolina, Columbia, South Carolina.

OCCLUDED GASES IN COAL. Bulletin 52. By S. W. Parr and Perry Barker, 28 pages, 6 x 9 inches. Published by the University of Illinois, Engineering Experiment Station, Urbana, Ill.

PROCEEDINGS OF THE FOURTEENTH ANNUAL CONVENTION OF THE NATIONAL ASSOCIATION OF MANUFACTURERS. 270 pages, 6 x 9 inches. Issued from the secretary's office, 170 Broadway, New York.

PROCEEDINGS OF THE SEVENTEENTH ANNUAL CONVENTION OF THE TRAVELING ENGINEERS' ASSOCIATION HELD AT DENVER, COLO., September 7-10. 396 pages, 6 x 9 inches. W. O. Thompson, secretary, Buffalo, New York.

PROCEEDINGS OF THE SEVENTEENTH ANNUAL CONVENTION OF THE INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION AT NIAGARA FALLS, N. Y. August 17-19, 1909, 189 pages. 6 x 9 inches. A. L. Woodworth, secretary, Lima, Ohio.

INDUSTRIAL PEACE AND INDUSTRIAL EFFICIENCY. 30 pages, 5¼ x 8 inches. Published by the Anti-Boycott Association, 27 William St., New York.

This pamphlet is a reprint from an English publication giving the terms of Sir Christopher Furness' co-operative scheme, or "The Treaty of the Hartlepools."

FUEL TESTS WITH HOUSE-HEATING BOILERS. Bulletin No. 31, by J. M. Snodgrass. 108 pages, 6 x 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

The bulletin reports 130 tests of anthracite, Pocahontas, coke and Illinois coal made in connection with two types of house-heating boilers. The efficiency obtained varied from 44 to 66 per cent.

LOCOMOTIVE BREAKDOWNS. By George L. Fowler and William W. Wood. 292 pages, 4¼ x 6½ inches, illustrated. Published by Norman W. Henley & Son, New York. Price $1.00.

This work, which was first published in 1903, has passed into the sixth revised and enlarged edition. It is in catechism style, the questions selected being based on the experience of engineers, air brake inspectors, and others connected with locomotive operation and maintenance. The contents by chapters are: Defective valves; accidents to the valve

motion, Stephenson link gear; accidents to cylinders, steam, chests, and pistons; accidents to guides, crossheads, and rods; accidents to the valve motion, Walschaerts radial gear; accidents to running gears; truck and frame accidents; boiler troubles; defective throttle and steam connections; defective draft appliances; injector troubles; accidents to cab fixtures; tender accidents; miscellaneous accidents; accidents to compound locomotives; tools and appliances for making engine repairs; locating and remedying air-brake troubles; the Pyle National electric headlight; rules, tables and other information. The details of the Pyle National electric headlight are illustrated on a folding plate.

PRACTICAL ENGINEER POCKET-BOOK AND DIARY FOR 1910. 684 pages, $3\frac{1}{2} \times 4\frac{1}{2}$ inches, in addition to which are many pages of advertising and blank pages for the diary. Published by the Technical Publishing Co., Ltd., 55-56 Chancery Lane, London, England. Price, leather, 1s. 6d.; cloth, 1s.

A great fund of useful engineering information is contained in the limits of this convenient pocket-book, as is shown by the following partial statement of contents: Standard of weights and measures, areas of small circles advancing by decimals, areas of circles up to six inches diameter advancing by thirty-seconds and sixteenths, areas of circles advancing by tenths from 1 to 100 inclusive, tables of squares, logarithms, chords, wire gage and metric conversion, steam boilers and furnaces, chimneys, boiler fittings, feed water, boiler joints, boiler trials, steam consumption, properties of saturated steam, indicator dimensions, steam engine details, sizes of steam pipes, relative strength of solid and hollow shafts, heating of buildings, condensers, steam engine regulation, springs, beams, steam turbines, gas producers, gas engines, refrigeration, water turbines and Pelton wheels, pumps, gearing, belting, chain driving, rope driving, emery grinding, limit gages, speed of cutting tools, power required for machine tools, pyrometry, cranes, ball bearings, roller bearings, reinforced concrete, strength of materials, etc.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION, 1908. 801 pages, 6 x 9 inches; illustrated. Published by the Smithsonian Institution, Washington, D. C.

This well-known publication contains the report of the Smithsonian Institution and, as has been the custom for some years, a series of valuable technical articles on various phases of scientific development, as follows: "The Present Status of Military Aeronautics," by Major George O. Squier; "Aviation in France in 1908," by Pierre-Roger Jourdain; "Wireless Telephony," by R. A. Fessenden; "Phototelegraphy," Henri Armat; "The Gramophone and the Mechanical Recording and Reproduction of Musical Sounds," by Lovell N. Reddie; "On the Relations Between Matter and Ether," by J. J. Thomson; "Development of General and Physical Chemistry, during the past Forty Years," W. Nernst; "Development of Technological Chemistry during the last Forty Years," by O. N. Witt; "Twenty Years' Progress in Explosives," by Oscar Guttmann; "Recent Researches in the Structure of the Universe," by Prof. Dr. J. C. Kapteyn; "Solar Vortices and Magnetism in Sun Spots," by O. G. Abbott; "Climatic Variations: Their Extent and Causes," by Prof. J. W. Gregory; "Uranium and Geology," by Prof. John Joly; "An Outline Review of the Geology of Peru," by George I. Adams; "Our Present Knowledge of the Earth," by E. Wiercher t; "The Antarctic Question—Voyages Since 1898," by J. Machat; "Some Geographical Aspects of the Nile," by Capt. H. G. Lyons; "Heredity, and the Origin of Species," by Daniel T. MacDougal; "Angler Fishes: Their Kinds and Ways," Theodore Gill; "The Birds of India," by Douglas Dewar; "The Evolution of the Elephant," by Richard S. Lull; "Life and Work of Lord Kelvin," by Silvanus P. Thompson, etc.

THE GAS TURBINE. By Henry Harrison Suplee. 262 pages, 6 x 9 inches. 93 illustrations and diagrams. Published by J. B. Lippincott Co., Philadelphia, Pa. Price, $3.

The intention of the author in publishing this work was to place in the hands of engineers and experimenters such theoretical and practical data as are now available in the solution of the problems of the gas turbine. The historical chapter describes early experiments and illustrates some early forms of gas turbines. Papers read before the Institute of Mechanical Engineers are digested, as well as a paper presented before the Society of Civil Engineers of France. Chapter V discusses the actual behavior of gas engine nozzles, giving account of experiments of Dr. Charles E. Lucke, and describes and illustrates the practical work of Messrs. Rene Armengaud and Charles Lemale. In the last chapter the author draws some general conclusions. So far as predictions may be made, it appears that the most immediate results are to be expected from the so-called "mixed" turbine, that is the type in which the injection of water for cooling purposes causes the machine to partake of the combined nature of the gas and steam turbine. Also, the turbine of the explosive type appears to have arrived at the practical stage already, notwithstanding its low thermal efficiency. Its efficiency, however, is about the same as that of the steam engine of the same capacity. The advantages of the turbine type are so great for certain purposes that Prof. Langley is quoted in speaking of the engine of his flying machine, whereof he said: "It might burn gold, if necessary, so long as it fulfills all the other requirements of the problem." In short, the mechanical advantages of the gas turbine may outweigh its disadvantages, in thermal efficiency and other respects. In this connection it is interesting to note that a new development in gas turbines will soon be announced that will startle the aeronautical world because of the simplicity of the motor and propeller.

MODERN GAS ENGINES, AND THE GAS PRODUCERS. By A. M. Levin. 485 pages, 6 x 9 inches, 100 illustrations. Published by John Wiley & Sons, New York. Price, $4.

The literature on the gas engine is rapidly assuming the importance and profuseness of that on the steam engine. It is fitting that it is so, for the internal combustion engine undoubtedly is the coming motor. It, with the gas producer, will gradually displace the steam engine for the majority of power-producing purposes. The thermal efficiency of the gas engine is higher than that of the steam engine; in certain industries, as the steel manufacture, it offers means of directly converting waste gases into power without the loss and complicated apparatus inseparable from the steam engine. The author in his foreword speaks of the importance of economy in national fuel resources and points to the gas engine as being one means of conserving them. The contents by chapters are as follows: Introduction to Thermodynamics; Design Constants and Formulas; Theoretical Analyses of Gas Engine Cycles; Power, Size and Speed of Gas Engines; Fuels and Combustion; the Proportioning of Mixtures and the Relation of these to the Size of the Engine; Alcohol Fuels; Features of Practical Gas Engine Cycles; the Fly-wheel; the Crankshaft; Engine Details; Governing; Engine Auxiliaries; Various Gas Engine Types; Producer Gas and Gas Producers. The work treats of gas engines with particular reference to the stationary types for general power purposes. While automobile engine design is not neglected, the importance of this specialized type would seem to have merited considerably more attention than the author gave it, especially when it is conceded that the automobile development has had a great improving influence on small internal combustion motor design. Space will not permit of a more detailed reference to the otherwise excellent phases of the work, except to say in conclusion that it is essentially a book for the designing engineer. The treatment of stresses in crankshafts, thermodynamics, etc., should give the average designer bases on which to work in almost all phases of gas engine design.

GAS, GASOLINE AND OIL ENGINES. By Gardner D. Hiscox. 476 pages, 6 x 9 inches, 370 illustrations. Published by Norman W. Henley & Son, New York. Price, $2.50.

This book, which was first published in 1897, has passed into the eighteenth edition. It was revised and extended by the author before his death. In the foreword he says that the gasoline engine has almost superseded the windmill for farm and suburban use and many manufacturers are employing it in preference to electricity for portable machines. It is estimated that there are about 10,000 manufacturers of gas, gasoline and oil engines in the United States. The author gives an account of the historical progress of the internal explosive motors, and follows with the theory of gas and gasoline engines, isothermal and adiabatic law, formulas and examples, tables, utilization of heat and its efficiency in explosive motors, temperatures and pressures, formulas and examples, retarded combustion, wall cooling and compression efficiencies, advanced ignition, compression in explosive motors and its work, causes of loss in efficiency in explosive motors, form and influence of combustion chamber, economy of gas engine for electric lighting, merits of the two- and four-cycle type, gas engine fuels, carbureters and vaporizers, cylinder capacity of gas and gasoline engines, governors and valve gear, explosive motor ignition, cylinder lubrication, constructive details and dimensions, measurement of power, gas engine testing, marine gas engines, motor bicycles, producer gas and its product, etc. The automobile and marine types of internal combustion motors are exhaustively treated, a large number of forms and constructions being illustrated and described. This section makes this work particularly acceptable to many designers concerned with the design of small motors. Practical hints on assembly are given in the chapter of construction and details and parts of explosive motors. The well-known method of using strips to set the piston rings when entering the piston into the cylinder, is illustrated and described. The author saw fit to give credit for it to a gas engine designer, but as a matter of fact, this method was in common use long before the engineer named was born. The work as a whole is heartily commended.

CATALOGUES AND CIRCULARS

GENERAL ELECTRIC CO., Schenectady, N. Y. Circular of tungsten automobile electric lamps.

WARREN WEBSTER & CO., Camden, N. J. Booklet on the Webster modulation heating system.

McDOWELL, STOCKER & CO., 121 N. Jefferson St., Chicago, Ill. List of second-hand machine tools.

NEW YORK MACHINERY EXCHANGE, 50 Church St., New York. List of second-hand machine tools.

H. W. JOHNS-MANVILLE CO., 100 William St., New York. Circular of "Sanitor" closet seats and tanks.

UNIVERSITY OF ILLINOIS, Urbana, Ill. Circular of information of the Department of Mining Engineering.

SPRAGUE ELECTRIC CO., New York. Bulletin No. 110 superseding bulletin No. 107 on Sprague electric generators.

SARGENT STEAM METER CO., 271-285 East Madison St., Chicago, Ill. Catalogue of Sargent automatic gas calorimeter.

CINCINNATI-BICKFORD TOOL CO., Cincinnati, Ohio. Circular R-50 illustrating and describing the Bickford $2\frac{1}{2}$-, 3- and $3\frac{1}{2}$-foot plain radial drill.

CLEVELAND PUNCH & SHEAR WORKS CO., Cleveland, Ohio. Handbook and stock list of machines and small tools for the fabrication of iron and steel.

PAWTUCKET TOOL CO., Pawtucket, R. I. Circular of Thompson automatic tapping chuck, which is made in both reversing and non-reversing types.

HUNTER SAW & MACHINE CO., 37th and Butler Sts., Pittsburg, Pa. Circular and price list C of circular metal-cutting saws, saw sharpening machines, etc.

LEIMAN BROS., 62 John St., New York. Circulars of pressure blowers (see MACHINERY, January, 1909), sand blast apparatus, melting furnaces, etc.

WESTERN ELECTRIC CO., 463 West St., New York. Bulletins No. 5131 and 5132 on motors and generators, type IL, and interpole motors, type ELC.

ECK DYNAMO & MOTOR CO., Belleville, N. J. Circular of Eck motors and dynamos of protected, enclosed, Manchester, back geared, vertical, variable speed and worm gear types.

HOWELL & MURRAY, Waverly, N. Y. Circular of the Howell adjustable work clamp for clamping work to lathe faceplates, boring mill tables, planer platens, etc.

SPRAGUE ELECTRIC CO., New York. Circular of Sprague "multilets." These junction boxes for electric service are made of stamped steel in two sizes with a set of covers for each size.

RICHARD W. JEFFERIS CO., Camden, N. J. Folder illustrating the Jefferis pressed steel lockers, unit construction, for use in armories gymnasiums, factories, clubs, stores, schools, offices, etc.

COMMERCIAL MOTOR CAR CO., Times Building, New York. Circular of commercial motor vehicles of gasoline and electric types for transportation systems, comprising light and heavy express wagons, trucks, etc.

E. C. BLISS MFG. CO., 91 Sabin St., Providence, R. I. Circular of the Bliss milling attachment for upright drills and drill presses. With this attachment, the ordinary drill can be converted into a vertical milling machine.

BROWN & SHARPE MFG. CO., Providence, R. I. Pamphlet on differential indexing, containing formulas and examples for differential indexing, and tables giving gears and index moves from 2 to 382 divisions, inclusive.

WHEELER CONDENSING & ENGINEERING CO., Carteret, N. J. Booklet entitled "A Radical Improvement in Jet Condensers," being a reprint of the article published in the *Iron Age* on the improved condenser made by the company.

NAYLOR BROS., 50 Church St., New York. Price list No. 1 of power transmission apparatus comprising Naylor adjustable ball and socket shaft hangers made with double brace parting hanger, wick oiling and babbitted bearings.

VILLINGER MFG. CO., Williamsport, Pa. Circular of the Williamsport 14-inch friction drill with quick-change speed device. The machine will drill to the center of a $14\frac{1}{2}$-inch circle and its spindle is fitted with No. 1 Morse taper.

WESTERN ELECTRIC CO., 463 West St., New York. Bulletins Nos. 1001, 1002, and 1105 on magneto non-multiple switch-board with manually restored line signals, magneto multiple switch-board with self-restored line signals, and intercommunicating telephone system, respectively.

KINKEAD MFG. CO., 7 Water St., Boston, Mass. Pamphlet describing the Kinkead method of aligning and leveling shafting, including setting up machinery, countershafts, grading steam and water pipes, and the common method in indoor and outdoor surveying for manufacturing plants of all kinds.

CHARLES GREINER, New Haven, Conn. Card advertising high-speed elastic blow combined riveting and spinning machine which is especially adapted for the assembly of general hardware, typewriters, etc. The machine strikes 6,000 blows per minute, and is claimed to rivet faster than work can be handled.